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Note on the reorganisation of technical instruction for enginemen on the Belgian State Railways,

By

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Figs. 1 to 11, pp. 251 to 263.

The interruption in the working of the Belgian State Railways during the occupation of the country by enemy troops prevented, for four years, the ordinary growth of the engine shed staffs, and especially as regards drivers. At the same time, due to various causes, gaps were formed in the ranks of the enginemen which contributed to the shortage of competent men necessary for the safe working of locomotives.

The Administration of the Belgian State Railways thus found itself in a very awkward position when, after the armistice, it had to take over again the working of the railways and make use of men as drivers whose experience and knowledge were far from what it should be. This state of inefficiency naturally included the firemen also from whose position drivers are recruited.

On the other hand, the institution of the eight hour day and the weekly rest for the train staffs necessitated a simultaneous increase in the number of men required for working any particular service.

These various causes coming together had the effect of very considerably lowering the professional standard of our engine drivers, and if we add to this a general weakening in the desire to be instructed — due to that period which upset everything and of which the consequences still exist — it will be clear how necessary it was to deal with the question.

The importance of this problem is evident, for the qualities of a driver are of first importance as far as the economical working of the line is concerned, being intimately connected with the judicious use of fuel, the proper working of the engines and the running of trains in general. Is it possible to imagine for an instant that costly and complicated engines like those of today should be placed in the hands of ignorant men who have been insufficiently prepared for their duties?

* * *

The institution of the eight hour day and weekly rest was supposed, however, to increase the efficiency of the staff which should compensate up to a certain point at least for the shorter working day. This increase in efficiency renders necessary, especially as far as engine drivers are concerned, a more complete knowledge of their work, and a more extensive instruction in its various branches. The new system gives him time to learn and adapt himself to the new working conditions.

Though the running staff has materially benefited by the latter, it has not as a rule made sufficient effort to improve its professional value, and it seems useless to count on its own initiative to help to modify this state of affairs. To do this we must, on the contrary, bring it into the right direction by organised instruction, the aim of which will interest the man in the end to be attained, and in which he will indirectly be obliged to study in order to arrive at the various stages in his career, and this instruction must necessarily be given outside the working hours as laid down on the principle of the eight hour day.

For this reason it has been decided that the staff should complete its instruction outside the working hours properly so called, and regular attendance of the classes should be one of the conditions of employment, so that attending the classes is to a certain extent compulsory.

* * *

As arranged before the instruction given was of the simplest kind, and the rules provided for a minimum compulsory attendance of two hours per month which were considered as working hours and paid for accordingly. However, even in admitting that these classes were regularly attended, they were quite inadequate, especially for preparing firemen who wished to become drivers, and because of the want of proper instruction which had become obvious, the reasons for which we pointed out at the beginning of this article.

These classes, reduced to their simplest form, could never be sufficiently complete in themselves nor be properly continuous in their work on account of the imperfect organisation, and the small funds at our disposal. They might also be reproached for wanting in uniformity, as all the teachers instructed according to their own personal ideas or aptitudes, only having a few administrative rules to guide them with.

* * *

It was in these circumstances that Mr. Vander Rydt, administrator, undertook the direction and reorganisation, according to his own views, of the instruction given to the locomotive staff.

This reorganisation comprises a series of measures tending to :

a) arrange for the classes to be sufficiently frequent and continuous, working at the same time to a uniform plan;

b) as far as possible to specialize as regards the instructors;

c) improve, complete and make uniform the apparatus used in the class rooms.

By this method we get as far as possible :

1° Uniformity in instruction;

2° Uniformity in the various apparatus, diagrams, etc., used for teaching.

These classes serve a double purpose : by their means it is possible to find out if members of the staff have sufficient knowledge necessary to fulfil their duties with safety, regularity, and economy; this is the strictest minimum that should be expected from them, and it is admitted that only two hours instruction per month is hardly sufficient to obtain this object.

Secondly, the classes endeavour to improve the teaching of the driver and to methodically prepare candidates for the position of driver to successfully attain the necessary standards by which they obtain the grading to which they aspire.

It is for this second object that efforts are more specially directed; the new classes that have been formed for this purpose and which the staff are expected to attend must evidently be held outside the usual working hours, thus making use of the free time, which is the consequence of the eight hour day, to complete and improve their professional education.

It was not feasible to extend the classes to the rolling stock employees on account of the expense involved. Professional associations understand the position, and admit and recommend the solution adopted.

* * *

Our report is divided into three parts :

1° Equipment;

2° Organisation;

3° Syllabus.

* * *

EQUIPMENT.

A distinction should be made between the ordinary class rooms and the car or travelling class room.

I. — Class rooms.

A new basis for arranging these rooms has been considered in order to fit them up with standard apparatus according to minimum requirements. The present apparatus now shown is insufficient and unsuitable and will be brought up to date according to the new standard.

The apparatus suggested for the class rooms will include :

a) *spare parts* (complete, those that may be taken to pieces, and sectional parts);

b) *models* to a smaller or larger scale (that may be taken to pieces and sectional);

c) *working models* on reduced scale;

d) *wall diagrams* (working designs and coloured drawings).

The apparatus should be as follows :

1. *Boiler.* — Wall drawing showing the longitudinal section of a complete modern locomotive boiler.

2. *Superheater.* — A set of wall diagrams showing sections of various kinds of superheaters.

3. *Feed.* — A Rongy and a Gresham injector in section (with spare parts). A holding up valve with safety cock, the casing being cut open. Various kinds of joints used for connecting the injector or feed pump to the pipes. Ball and socket

joint by means of which water is supplied to the injector from the tender.

4. *Safety appliances.* — A Wilson safety valve in section. A Bourdon pressure gauge opened out. A Dewrance water gauge, a « bouteille » water gauge and a German water gauge, all to be taken to pieces and fixed on a board. A fusible plug.

5. *Steam supply.* — A Walschaerts regulator and a double seated regulator.

6. *Valve gear.* — An ordinary piston valve.

A flat Trick valve.

A balanced flat valve.

A wooden model of an eccentric arranged so as to show the angle of advance and eccentricity.

A working model showing the Walschaerts valve gear.

A working model showing the Stephenson valve gear.

A set of wall diagrams showing the working of these gears with superheated steam (admission by the inside ports).

A set of wall diagrams showing the method of uncoupling the various parts of the valve gear in case of accident (parts to be numbered according to the order in which they are taken down).

A set of sectional coloured drawings showing the various types of piston valves in use on the Belgian State Railways.

Various arrangements of starting gear used for compound locomotives.

7. *Various accessories.* — Drain cock. Belgian State relief valve. German relief valve. Belgian State by-pass. German by-pass. A Gresham sanding arrangement. A pressure reducing valve for carriage warming purposes.

8. *Lubrication.* — *a*) Lubricators for the moving parts :

A Bergmarck lubricator.

A lubricator with fixed needle valve.

A lubricator with adjustable needle valve.

A lubricator with peg.

A lubricator with spindle.

A lubricator with peg and valve combined.

b) Cylinder lubricators :

A Nathan lubricator.

A Roscoë lubricator.

A Kessler lubricator.

9. *Brake work.* — A driver's brake valve with equalising release for the Westinghouse as well as for the A and B Knorr brakes. A detailed arrangement showing a Westinghouse pump with corresponding distributing parts. The regulating device for the Westhinghouse pump. A feed valve. Cock for working the brake direct. An ordinary triple valve. A rapid action triple valve. A double stop valve (all to be taken to pieces and in section). A set of descriptive and diagrammatic wall sketches showing the general arrangement and the fitting up of all parts of the Westinghouse brake, as well as the working of the pump, the driver's brake valve, the triple valves, the direct brake valve, the double stop valves, etc. Finally, a set of diagrammatic explanatory sketches designed to quickly show the working of the direct and automatic brakes combined.

10. *Signalling.* — Two drawings giving a general view of the three-position system of signalling showing on the one hand the meaning of the various signals, and on the other, the general application of the rules relating to signalling by numerous examples.

II. — **Classes held in instructional cars.**

Improvement lectures are also given in specially arranged cars running from

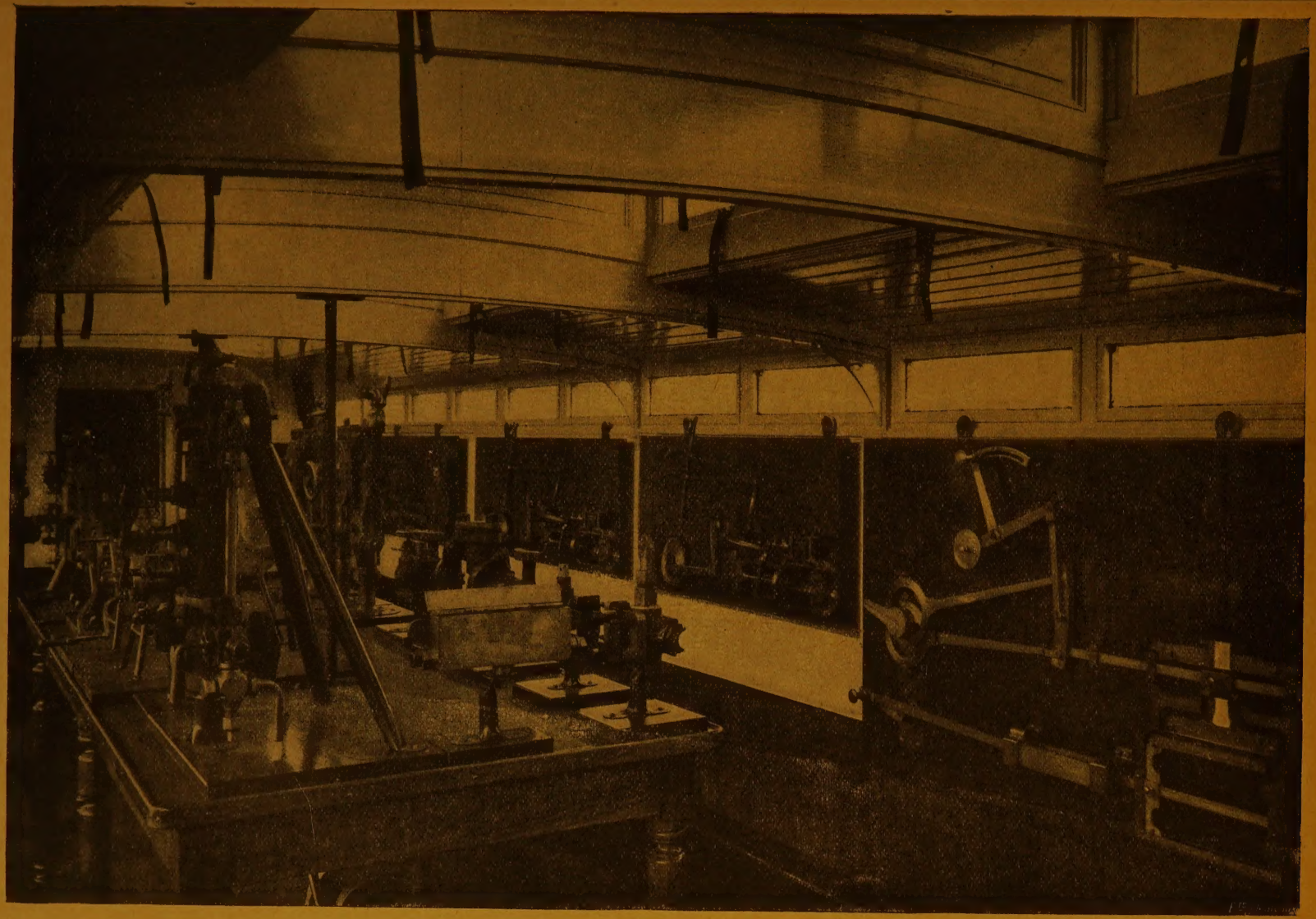


Fig. 1. — General view of lecture room in first car.

place to place. These lectures include a series of four, dealing respectively with the boiler, valve gear, brakes, and signalling. These lecture cars being itinerant, the instruction given from them is substituted at certain times for that of the class rooms. They are made up of two very large bogie cars joined together by means of a flexible gangway, and were formerly electric motor cars fitted with accumulators and since altered. These cars have now been fitted with the special and costly material that cannot be supplied to all the class rooms on account of their high cost.

The first car contains :

a) a room in which is fitted working and other models (fig. 1), showing the action of the boiler and especially the feed apparatus, steam delivery and safety appliances, as well as valve gears and lubricators;

b) a combined bedroom and office, fixed at the front of the car and containing a bed with the usual requisites, a writing table, gas stove, etc.;

c) a flush W. C. is fitted near the coupling up of the second car, and a receptacle containing the boiler of the thermo-syphon which supplies the necessary steam for heating the first car.

The second car contains :

a) a room for describing the working of the Westinghouse brake and signalling;

b) a dressing room fitted at the far end of the car;

c) a cupboard to hold various articles fixed near the coupling of the cars, as well as a receptacle for the boiler of the thermo-syphon supplying the steam for heating this second car.

Fittings in the first car.

Looking along the right hand side of the car from the front of the black board fixed at the end (fig. 1) may be seen five working models (beginning at the left) showing respectively the working of :

1° Valve gear with one eccentric arranged with variable valve travel and angle of advance and with interchangeable valve;

2° Valve gear with Walschaert's link motion for saturated steam;

3° Valve gear with Walschaert's link motion for superheated steam locomotives;

4° Valve gear with Stephenson's link motion with open rods for saturated steam;

5° Valve gear with Stephenson's link motion with open rods for superheated steam (see fig. 2).

All these models, made to a scale of 2/5 have been constructed with the greatest care so that their working may be accurately observed.

A table is fixed in front of the black board (shown in fig. 3) on which is placed various models of bogies made accurately to drawings to a scale of 1/5 (see fig. 4).

In addition, following the centre line of the same car, a table with shelves is placed (see figs. 1 and 4) on which is displayed and fixed to it the following apparatus, cut and arranged so that their action can be explained :

A Rongy injector (non-lifting);

A German injector (lifting and restarting);

A Metcalfe injector (lifting and restarting);

A Gresham injector (lifting and restarting);

A Roscoë lubricator;

A Kessler lubricator;

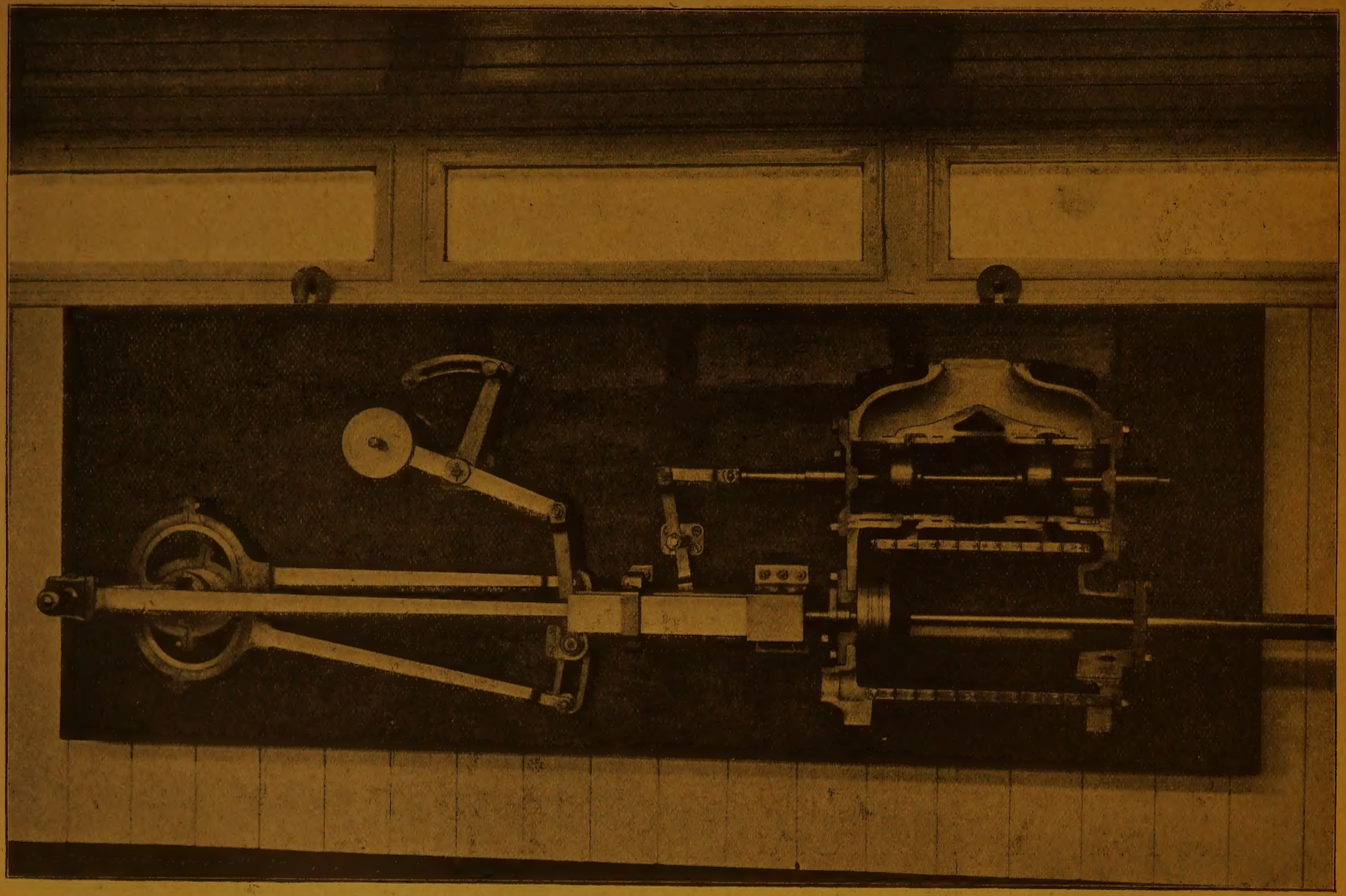


Fig. 2. — Working model of Stephenson's link motion for superheated locomotives.

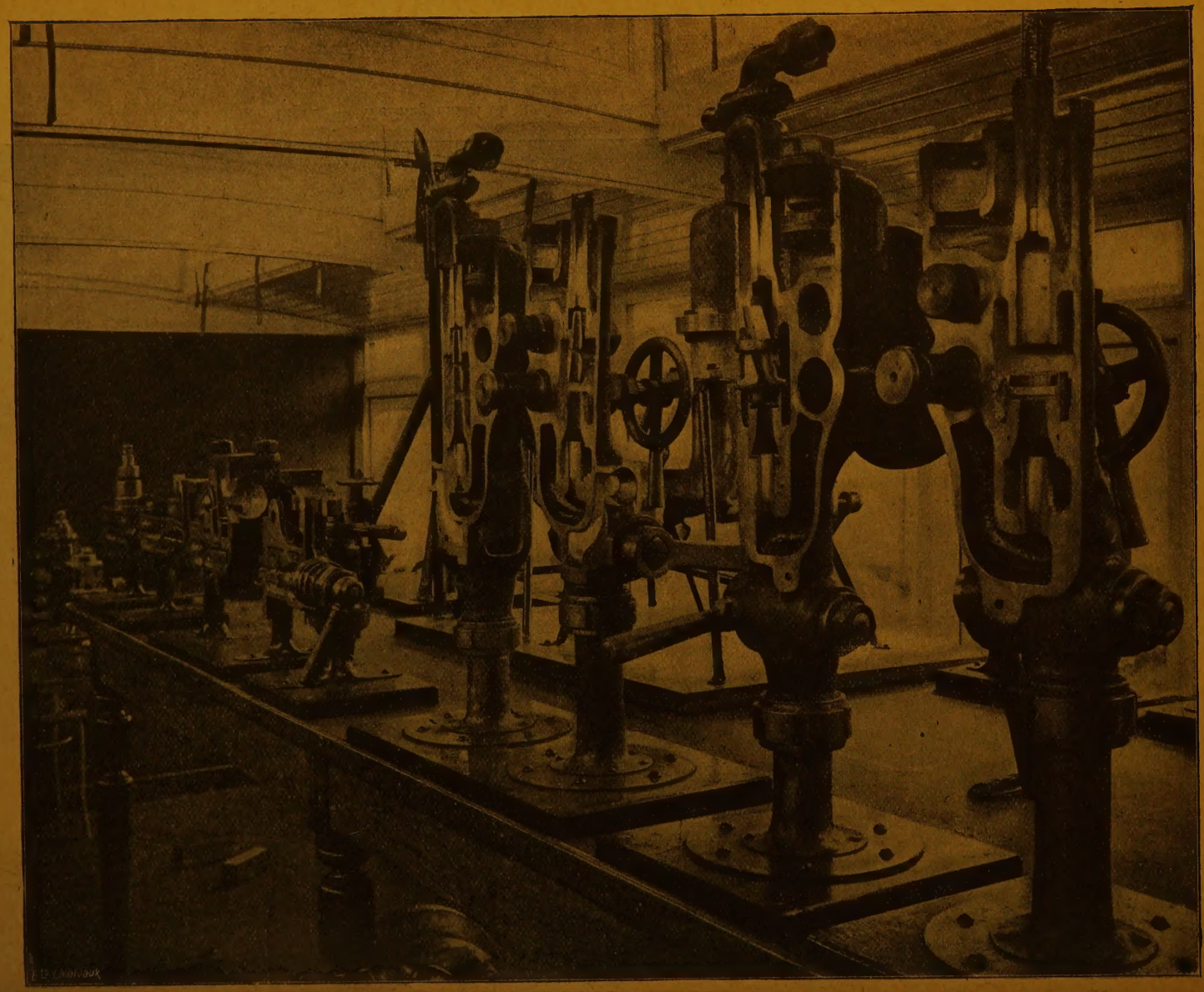


Fig. 3. — General view of table for models in the first car (black board visible at end).

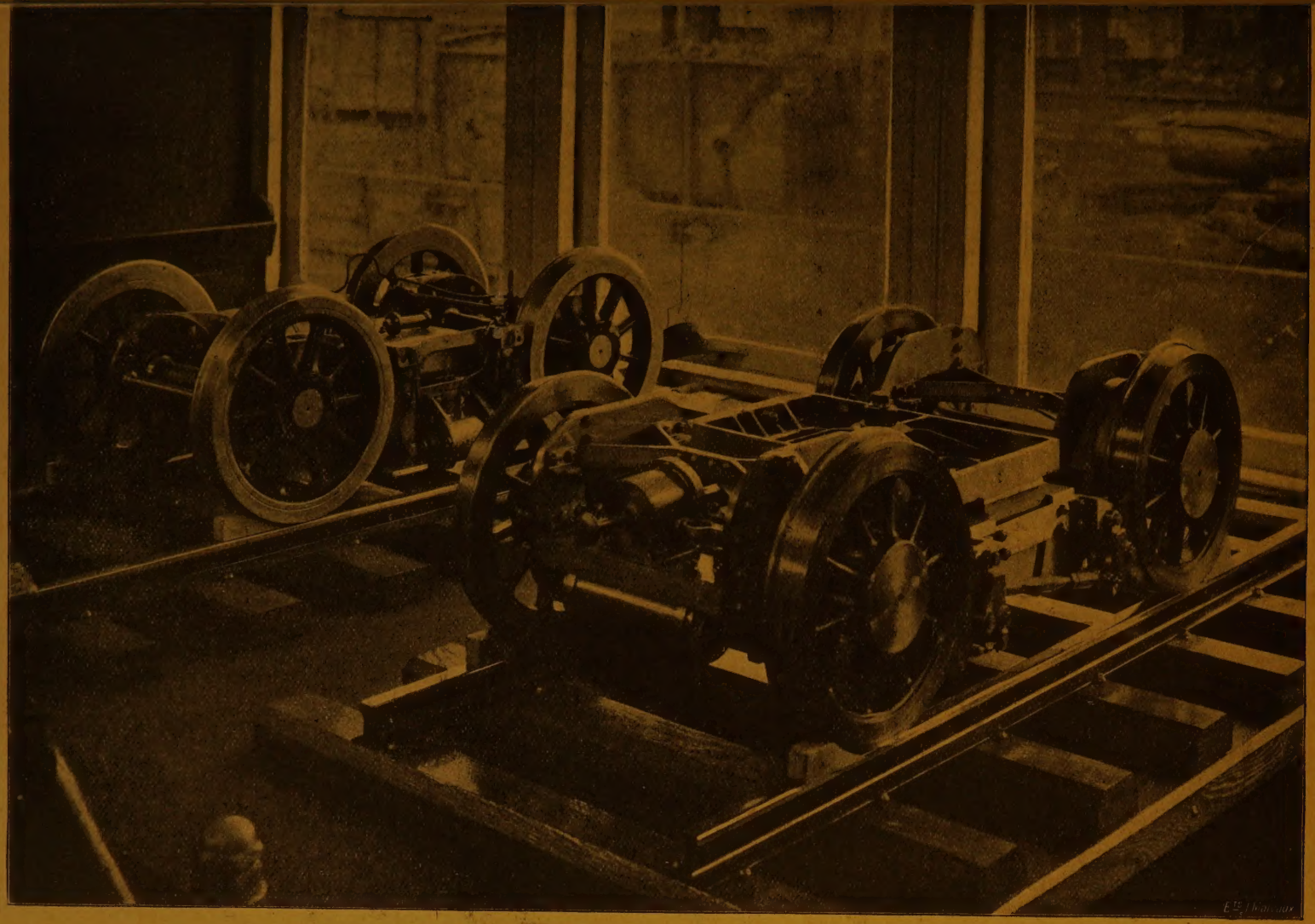


Fig. 4. — Models of bogies (scale of 1/5) placed in front of black board in first car.

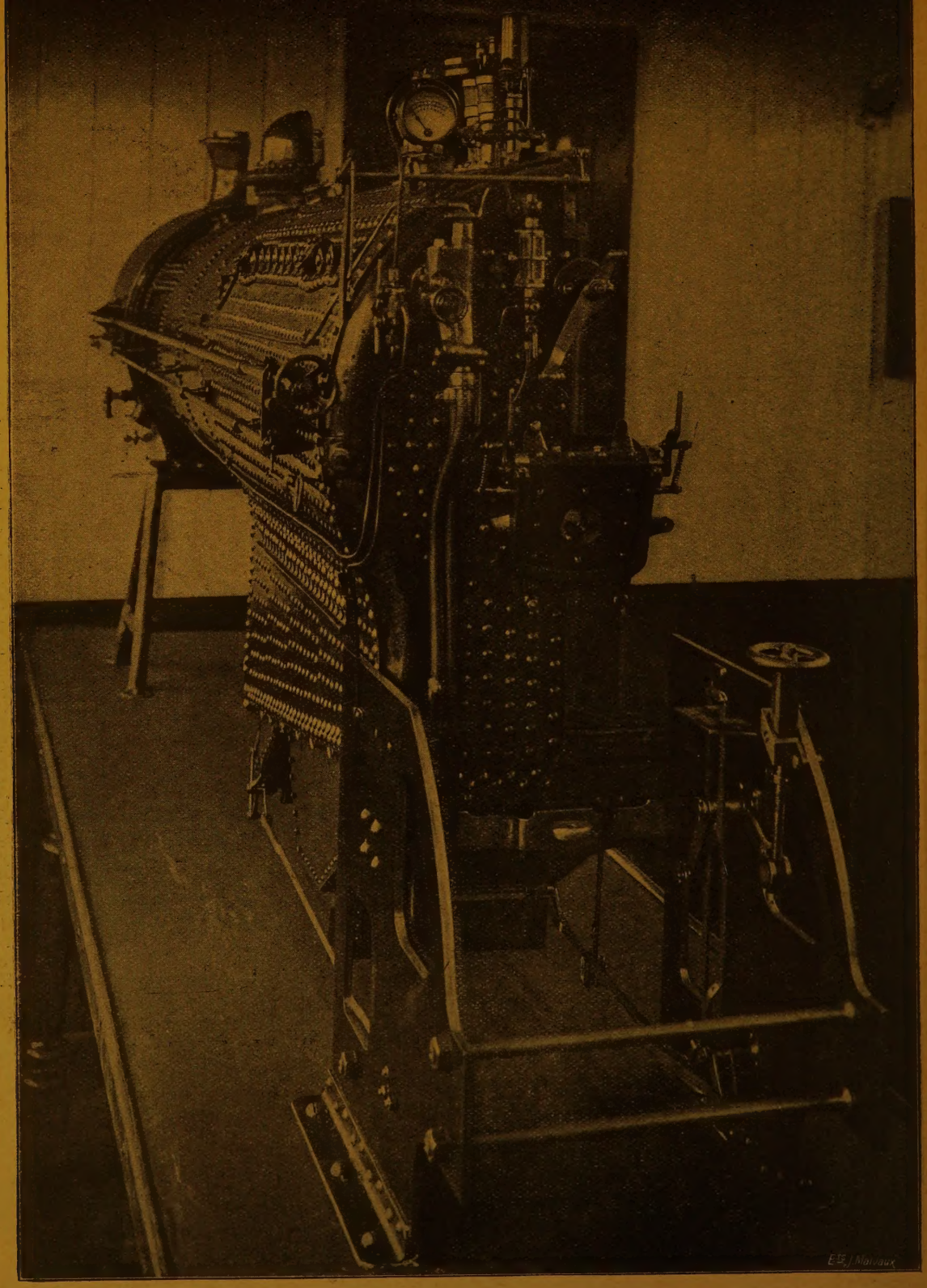
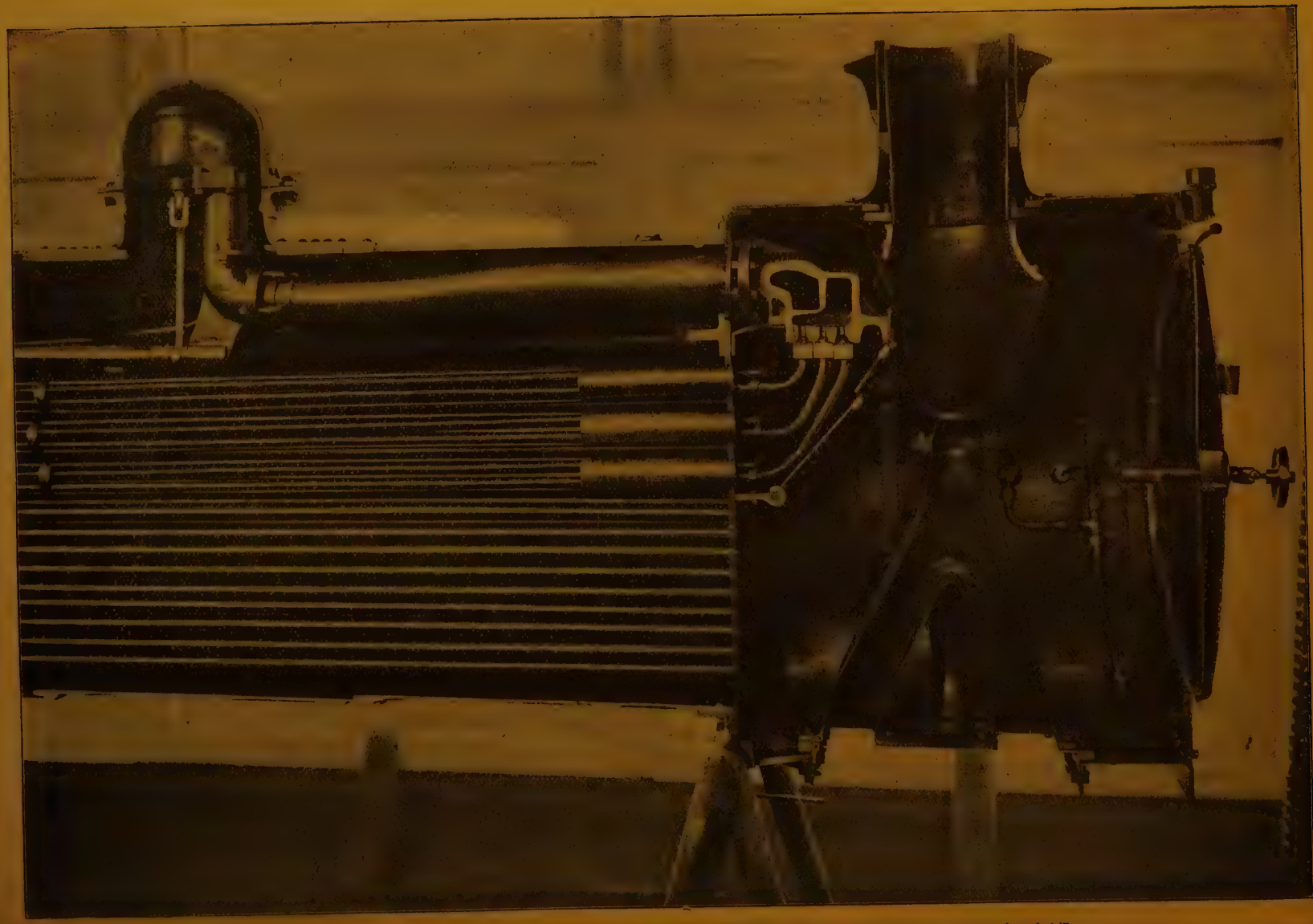


Fig. 5. — Section of a complete model of a type 9 locomotive boiler. Exact reduction to a scale of 1/5.

Fig. 6. — Section of complete model of a type 9 locomotive boiler. Exact reduction to a scale of 1/5.



complete model of a type 9 locomotive boiler. Exact reduction to a scale of 1/5.

A Nathan lubricator;
Various types of lubricators for the motion;
A Walschaert's regulator;
A regulator with double seated valve;
A Dewrance water gauge fitted to a small cylindrical vessel;
A Gresham sanding apparatus.
Underneath the table on a lower shelf are placed, a stuffing box, a superheater element, etc.

Finally, on the third table placed at the entrance of the car is fixed a complete sectional model of the boiler used on locomotives type 9, exactly reproduced to a scale of 1/5 (see figs. 5, 6 and 7). Later on a model of the mechanism of a compound engine will be added in order to complete the apparatus in the first car.

Apparatus in the second car.

1° Brake details.

a) *Westinghouse pump, model F.*

This pump (shown in fig. 8) is cut in numerous sections in order that the arrangement and working of the parts, the circulation of the compressed air and steam, as well as the action of the suction and delivery valves may be clearly seen. The distributing parts are worked by means of electricity, whilst the raising of the valves is reproduced by a mechanism worked by levers.

With the model so arranged, the instructor has only to turn the handle shown in the bottom part of figure 8, which through the medium of a screwed shaft, works the pump.

The action of all the various parts may then be seen by the students as occurs in reality.

In addition, a working coloured diagram (see fig. 9) is attached to the back of the apparatus which allows the students to more easily follow the paths taken by the compressed air and steam, as well as the action of the reversing and distributing valve.

b) *Complete brake apparatus.*

At the end of the car (fig. 9) is fixed a complete combined automatic and direct Westinghouse brake gear, which includes everything from the main reservoir fed by a special pipe down to the brake cylinder, the piston of which is balanced by means of a suitable system of springs. Each individual that is being taught can thus study the working of the various parts and see the relation they bear to the other elements of the brake. For this purpose a system of brake gearing is arranged and connected to a pipe 490 feet long, from which branches out every 49 feet, 10 combined groups of brake cylinders complete with auxiliary reservoirs and triple valves. The result of any faulty application of the driver's brake valve can then be seen, and the various causes of broken couplings, either due to this cause or to defects in adjustment, or upkeep of the parts, may thus be studied.

It should be noticed that the distributing apparatus on both engine and tender (see fig. 10) are connected to similar parts in section, working exactly as the parts do of which they are doubles.

The study of the working of each part, as well as the general action of the brake, is made clearer by means of a diagram on rollers fixed in a glazed frame, as shown in figure 11. This is unwound by means of the handle arrangement clearly shown in the figure.

2° Signalling.

In order to give instruction concerning signalling, a rectangular oak stand 3 ft.

Fig. 8. — Westinghouse pump, model F.

Fig. 9. — General view of the lecture room in the second car.

Fig. 10. — Complete installation of a Westinghouse brake equipment, automatic and direct combined.

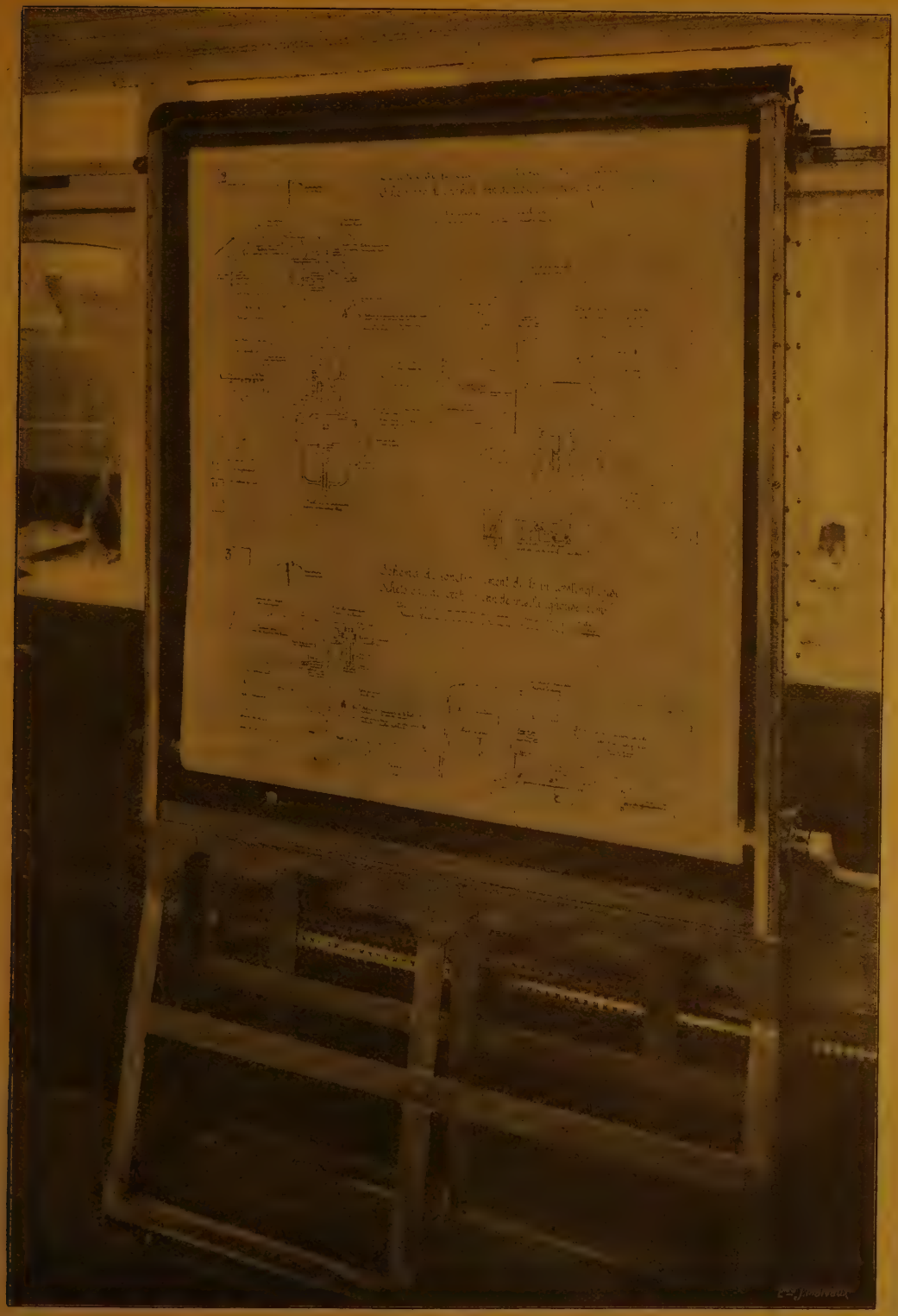


Fig. 11. — Glass fronted roller frame for studying the working diagrams of the Westinghouse brake.

3 1/2 in. × 6 ft. 7 in. and suitably arranged has been fixed down the centre of the car (see fig. 9). Under a sheet of glass serving as instruction table a series of diagrams may be unrolled showing typical examples of arrangements of lines, crossings, junctions, stations, etc. These diagrams have been drawn on a length of linen sheeting 2 ft. 9 1/2 in. wide and fixed to two rollers, one at either end of the stand, from which it is unwound by means of the handle shown in figure 9. This sheet also passes over two supporting rollers fixed across the interior of the table. The position of the signals is marked on it by red dots, so that all that is necessary in each particular case is to place the miniature signal with arm complete in any required position. The arms of these signals are worked by hand and can be placed in their proper positions. When one particular case has been dealt with, a turn is given to the handle and the next one appears, when the signals can be moved to their new positions or added to according to requirements. A reserve of signal models is kept in two drawers with compartments fixed in the lower part of the table.

* * *

The two cars are lighted with gas (Pintsch's system) supplied from independent reservoirs containing sufficient for a month.

* * *

ORGANISATION.

The two hours of actual instruction, the time taken up for which is paid for, takes place at all the running sheds, and is compulsory. In order to make this instruction general, twenty-three central class rooms (centres) have been fitted up at various locomotive depots of the railway. In these centres, in addition to the ordinary classes held outside working hours, fifty lectures per year, or one each week, are also given. The same subject is treated during the whole week, so that the instruction may be given to those whose working hours could not fit in with any particular fixed time, and thus enable everyone to follow the entire course. The syllabus of these fifty lessons is given at the end of this article.

The lectures given at these central classes began on the 1 January 1924 and will be repeated every twelve months, and must be followed during two periods of twelve months. They may be attended by any member of the running staff who are working in connection with locomotives, but are compulsory for firemen and those desiring to become engine drivers, and for those engine drivers who wish to sit for the examination to become inspectors. A form, as shown in the appendix, is filled up for each individual attending these courses of lectures.

The progress, etc., made in these classes as a result of questioning those desirous of becoming drivers, or driver inspectors, is noted each month on these forms, and the marks obtained is taken into consideration of the aptitude of the individual. In addition, those who have obtained the best results in their answers and shown an interest in their work will have priority of choice for entering the branch they particularly aspire to. On the other hand, as it is admitted that it is of little use attending technical classes without sufficient elementary knowledge, lessons of a preparatory nature have been instituted.

This preparatory instruction deals with the fundamental principes of *arithmetic* (the four rules, fractions, rule of three, the metric system and simple problems relating to the work engaged in), *physics*

and elementary mechanics (definition of common terms such as pressure, force, velocity, work, power, heat units, etc., used in the fifty lessons).

This preparatory instruction, which is compulsory for firemen aspiring to be drivers, and optional for others in the locomotive service desirous of improving themselves, is given each year for four months commencing on the 1 September in the centres, and permanently every four months in all the ordinary class rooms of the locomotive depots.

* * *

SYLLABUS.

A) List of the sixteen preparatory lessons.

I. — Arithmetic.

1. Enunciation and written description of whole and decimal numbers. Exercises : addition of whole and decimal numbers. Simple sums : subtraction of whole and decimal numbers. Exercises and simple sums giving answers and their working out. These questions have special reference to loading fuel on the tender.

2. Multiplication of whole and decimal numbers. Practical application with answers and working out of the sums.

3. Division of whole and decimal numbers. Practical examples relating to the allocation, consumption, and bonuses dealing with fuel.

4. Fractions, proportions and percentages; the rule of three. Problems (relation of heating surface to grate area, and superheated area to heating surface; also proportion of adhesive weight to total weight; proportion of fuel burned according to given conditions; speed of trains, etc.).

5. Measures of length, areas, volumes and weight. Multiples and submultiples in current use.

6. Applications of the metric system. Perimeter of a square, a rectangle and of a circle. Area of a square, a rectangle, a circle and of a cylindrical surface. Volume of a cube, a rectangular block and of a cylinder. Case in which the diameter of the cylinder cannot be measured (volume as function of the perimeter). Practical examples.

7. Practical examples and application of the metric system (perimeter and area of grates, cubical contents of fireboxes, heating surface direct and indirect, areas of blast pipes, volumes of known locomotive cylinders, pressure exerted by steam on pistons, etc.).

8. Elementary knowledge relating to drawing and geometry : the point, straight line, area and volume. Various lines. Straight, diverging, parallel, at right angles. Knowledge concerning angles : angles opposed at their apex. Bisection. Complementary and supplementary angles, etc. Fundamental properties of the circle.

9. Knowledge relating to elementary physics. Production of heat by means of fuel. Measure of heat quantities. Calories : definitions; specific heat.

10. Combustion : composition of fuels, solid matter (carbon) volatile (hydro-carbons) and incombustibles (ash). Complete and incomplete. Knowledge relating to the calorific value of fuels.

11. Rational method of firing : neither too much nor too little air. Calculations relative to this. Determination of the calorific value of fuels.

12. Production of steam by means of heat : measures of pressures. Vaporisation: boiling point, Regnault's law.

13. Sensible heat, heat of vaporisation, total heat, heat in superheated steam. Calculation relative to this.

14. Transmission of heat by radiation, by contact. Natural heating. Examples.

15. The part played by incrustation. Effects of expansion.

16. Production of work by means of steam. Knowledge relating to the unit of work or kilogrammetre. Unit of power : horse-power, the kilowatt. Economy of expansion. Calculations relating to above and remarks.

B) **Syllabus of the fifty lessons relating to technology and administrative knowledge.**

I. — TECHNOLOGY OF THE LOCOMOTIVE.

a) *Boiler.*

1. General description of the locomotive and its boiler.

2. The firebox and method of staying. Grate. Ashpan. Brick arch.

3. The boiler barrel. Tubes. Smokebox.

4. Safety and auxiliary apparatus fixed to the boiler.

5. Feed apparatus. General principle of the working of injectors. Giffard injector. Rongy injector.

6. Gresham and similar injectors. Causes of injectors failing and the remedies.

7. Feeding with heated feed water. Metcalf's exhaust injector. Feed pumps.

8. Various methods of delivering the steam. Walschaert's regulator. Lifting valve regulator.

9. Superheat. Superheaters in most general use.

b) *Framing.*

10. Frames. Suspension : wheels, axles, axleboxes, couplings.

11. Running on curves. Bogies. Radial bogies. Pony wheels.

c) *Motion and valve gear.*

12. General description of the working mechanism. Various packings.

13. Valve gear with one eccentric. Slide valve. Lap. Adjustment of the eccentric. Lead. Diagrams.

14. General theory of the link motion. Stephenson's and Walschaert's valve motions for saturated steam.

15. Stephenson's and Walschaert's valve motions for superheated steam. Chief points relative to four cylinder locomotives. Reversing gear.

16. Multiple expansion. Starting apparatus.

17. Cylinders. Drain cocks. Relief valve. Sanding apparatus. Piston. Crossheads. Slide bars. Cranks. Eccentrics.

18. Lubrication. Lubricators for working parts.

19. Condensing and mechanical lubricators for valve chests and cylinders.

d) *Brakes.*

20. Description of hand and steam brakes and reversed steam brakes.

21. General description of the Westinghouse brake. The governor and Westinghouse pump and method of lubricating the latter.

22. Description of the driver's equalis-

ing brake valve. Instruction as to its working (the five positions). Feed valve.

23. Description and working of the ordinary triple valve and of the rapid action triple valve.

24. Main feed pipe and accessories (alarm whistle, isolating cock, etc.). Couplings. Brake cylinders. Brake rods and levers and method of adjusting them.

25. Direct acting brake and automatic brake combined.

26. Knorr brake with vertical handle and four position valve.

27. Knorr brake with horizontal handle and direct brake combined.

28. Testing the brakes. Securing brakes. Measures to be taken on the road and on arrival.

II. — MANAGEMENT OF THE LOCOMOTIVE AND ORGANISATION OF THE STAFF OF DRIVERS AND FIREMEN.

29. Combustion. Rational use of various kinds of fuel. Management of the fire and of the boiler (feed, etc.).

30. Management of locomotives in general. Running with closed regulator.

31. Management of the superheated locomotive. Casualties with superheated locomotives.

32. Management of compound locomotives. Casualties with compound locomotives.

33. General duties and obligations of the drivers. Reporting complaints, entering up working sheets, etc.

III. — SIGNALLING.

34. Hand signals given by the staff and train signals.

35. Meaning of the lights, oral and hand signals, two position fixed signals.

IV. — RUNNING LOCOMOTIVES IN SERVICE.

a) *Working and running light engines. Accidents and irregularities.*

b) *Working and running trains. Accidents and irregularities.*

c) *Shunting service.*

V. — VARIOUS BREAKDOWNS AND MEASURES TO ADOPT.

47. General rules for cases of accident and measures to be taken in case of derailment.

48. Accidents to the boiler and its accessories.

49. Accidents to the working parts.

50. Accidents to the wheels or framing.

APPENDIX.

Form relating to. . . . .

Date when appointed . . . . { 1° fireman.
2° permanent driver.

Sheds allocated to.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total attendances.	Total marks out of 240.	Proportion of marks, the maximum of 240 being quoted as 30.	*Remarks.*
	19...																
	A																
	B																
	C																
	19...																
	A																
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A = Number of attendances at ordinary classes.
B = Number of attendances at the central classes.
C = Monthly results.

[656. 254 (.68)]

Rolling-stock and train control on the South African Government Railways.

Figs. 1 to 14, pp. 271 to 293.

(*Railway Gazette.*)

The South African Railway Administration has nine divisional offices, operating a total of 11 478 miles of track (all single line except for 167 miles), spread over an area larger than the total square mileage of the following countries combined : British Isles, France, Germany, Spain, Italy, Denmark, Portugal, Greece, Switzerland, Holland and Belgium. The divisions are grouped into four « systems », each being under an Assistant Manager. For control of rolling-stock the divisions deal direct with the General Manager's office.

Except on the branches with a limited train service, where drivers and guards are handed a printed « authority to proceed form », filled in and issued after the exchange of telegrams between stationmasters, the trains on single lines are worked on either the electric staff or electric tablet system. On double lines three-position block instruments are used, the dense sections having track-circuiting devices in addition.

Means of communication

Single line train working would afford excellent opportunities for economy and improved efficiency in operation by adopting « control » methods if the means of communication were suitable for the purpose. The latter, however, are mostly by telegraph with instruments of the Morse recording type and with « Phonopore » speech superimposed. The electrical experts of the South African Railways have to contend with many difficulties which are, perhaps, not experienced elsewhere, such as stretches of rocky country hundreds of miles in length where rain may not fall for twelve months or more. Metallic return circuits are out of the question on account of expense, and with the poor earth available, both distance and clearness of speech are limited. Another difficulty, also due to economy, is the presence of long-distance postal telegraph lines on the same poles, causing heavy induction from Wheatstone circuits, and others which interfere with speech on the « Phonopore » instruments. To have achieved any form of « control » by telephonic equipment is, therefore, a matter for congratulation.

Conservation of rolling-stock.

During the late war the coal bunkering and other traffic increased considerably, and there was also the movement of war stores to and from the campaigns in the late German East and West African territories, causing a very heavy demand for trucks. In common with other railways throughout the world there were a depletion of artisan staff and shortage of material, so that the renewal and repair work were much below normal. The shortage of trucks was remedied in a great measure by the introduction of « rolling-stock control ».

Sir William Hoy, the General Manager of the Union Railways, with his lengthy practical experience covering all parts of the South African Railways, realised

that methods of control which would suit one division would not necessarily suit another, and, while urging upon his principal officers the need for conservation of truckage and more scientific methods of distribution, allowed his divisional superintendents to carry out control method to suit their own widely differing local conditions.

At some date in the near future comparisons of methods and results will no doubt be made, and the best features of each incorporated into one control system. The main principles, at least, are already uniform, the differences in methods being due to the variety of difficulties to be overcome, the varying nature of train services, and differing facilities for communication. In Division 6, for instance, the traffic is chiefly in bulk, and the regulation of engine power and also the intensity of train service, are ever present problems. Division I has not the same intensity of train service, but has a heavy internal or local traffic which offers scope for economy in truckage, and working of pick-up trains. Division 2 has to deal principally with heavy train-loads passing through. Several of the divisions require to concentrate attention upon load changes due to varying gradients. It will be apparent that the officers at Central Control must necessarily be conversant with the traffic and operating peculiarities of all the divisions.

Central Control of rolling-stock.

The Central Control Office is at the headquarters of the General Manager, *viz.*, Johannesburg, and has been in existence many years. Divisional offices telegraph each day the summarised particulars of rolling-stock on their divisions. Daily balances for each division are maintained, as from the last census, on « exchange » information sent every 24 hours from the border stations of the divisions. A « normal working » programme for flow of empties throughout the Union is in force, which generally provides for the shortest empty mileage of trucks to centres where there is a daily demand for specified types.

The Central Office in Johannesburg is kept well advised of prospective arrivals of ships, movements in the grain and cattle markets, forthcoming agricultural shows, stock sales, etc., and is therefore in a position to restrict, augment, or divert the flow of empties as reflected in the divisions' reports of spare trucks despatched on the normal routes. A form used for this purpose by the Central Control Office gives particulars of tonnage on hand and despatched during the previous 24 hours, at all principal « staging » stations throughout the system, in order to indicate where action is necessary to avoid congestion at any particular point. With the advent of divisional « control » the information received at Johannesburg has become more accurate, and shows the actual position at a closer hour to the receipt of the information than was possible formerly. Conversational telegrams from the Central Control Office to the divisions, acquainting each very briefly with the position in other parts of the Union, are also a feature of the system.

Each divisional control is required to act in accordance with general instructions telegraphed from the Central Control in the matter of sending trucks to other divisions. The loading of a portion of local traffic within a division is held back when necessary, in order to rush empties to another division perhaps a thousand miles away, when Central Control so instructs. Empty vehicles are for this reason sometimes given preference in transit over loaded vehicles.

Divisional rolling-stock control methods : Division 1

Division 1, extending from Cape Town to De Aar, with several important branch

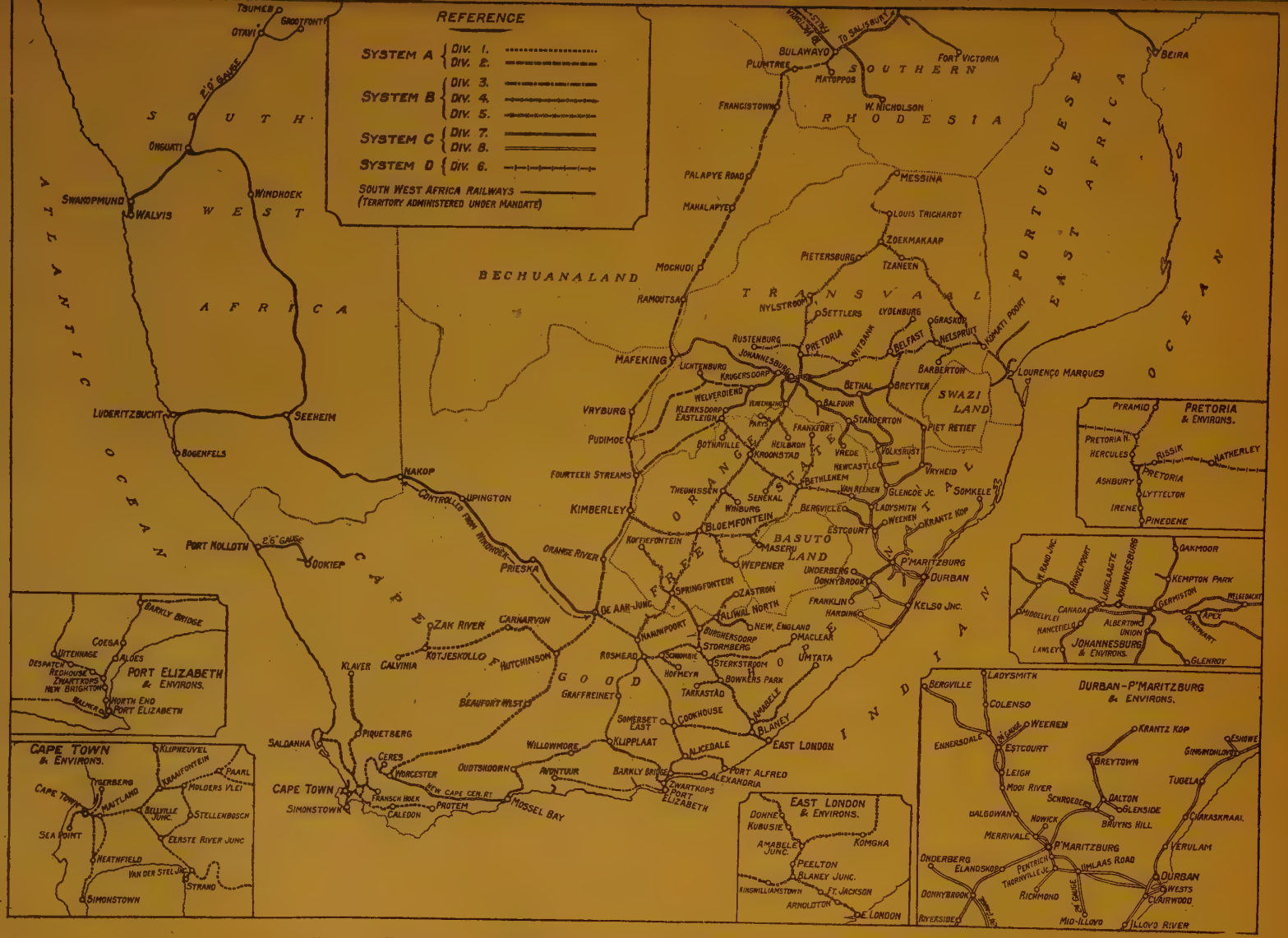


Fig. 1. —General map of South African Railway system, showing control divisions.

lines, has a divisional Control Office at Cape Town, and sub-control offices at the principal engine depot stations. At each of the sub-controls a chalk board is provided. That in use at Caledon is shown in figure 2. Each station is required to telephone to its sub-control at specified times, twice a day, full particulars of the yard in the manner laid down on the control advice, and, at other suitable hours, based upon the train service, latest particulars under items A, B,

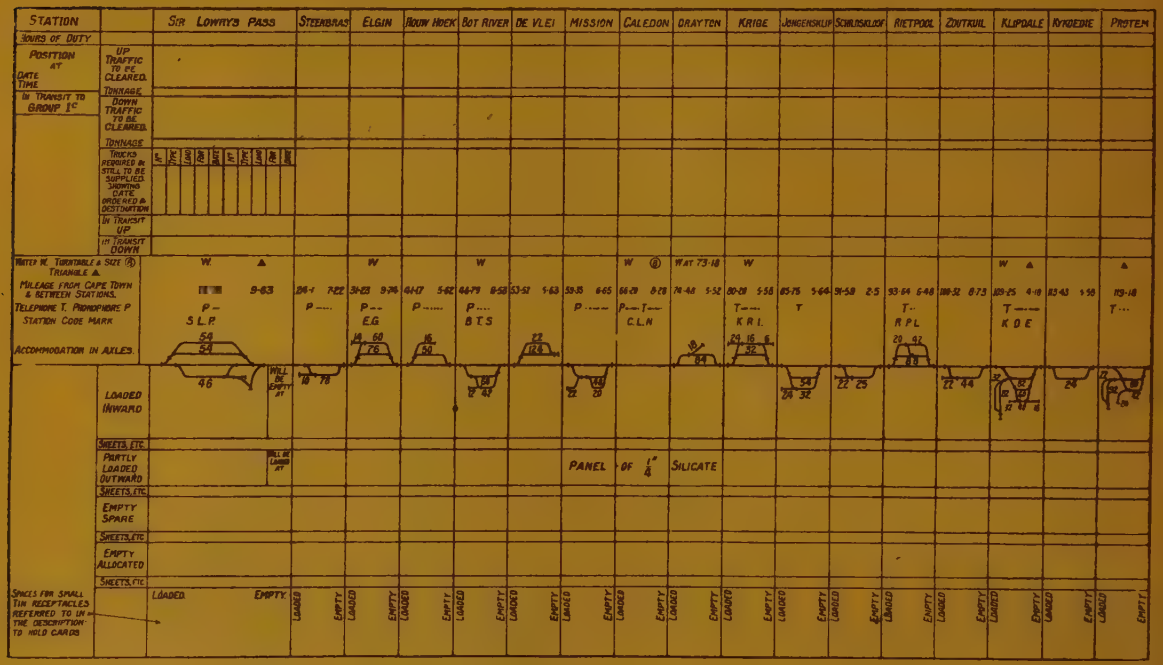


Fig. 2. — Rolling-stock record board in use at Caledon, division 1.

E and F. The headings of this form are shown in closed up form in table 2. Instructions on the back are as in table 1.

The sub-control stationmaster thus has before him a view of the whole section, and supplies suitable trucks from the nearest available point, sending loaded trucks if possible, but not supplying more vehicles than can be cleared, when loaded, by the engine power at his disposal. Loaders are encouraged to place orders a few days ahead, which arrangement assists the staff to curtail the empty truck mileage.

The sub-control stationmaster telephones each afternoon to the Divisional Control Office summarised particulars of the requirements which he is not able to meet out of his own spares, together with details of the spare types he has, and brief information regarding the loaded trucks labelled to other sub-controller's sections.

After co-ordinating the information received from the different sub-controls, and taking into account all loaded trucks ready for transit (or already in transit) which can reasonably be expected to arrive on the sections by the following morning, the Divisional Control staff issue instructions for the transfer of empty trucks from one section to an-

TABLE 1.

Instructions regarding Control Advice.

NOTES.

From (Insert Station Name).

For (Insert Name of Unattended Siding).

A — UP LOADED TO CLEAR.

1st Wire. — Show each truck separately. If for a station on the Section, show number of sheets, etc. Gross tonnage to be shown for clearance arrangements.

Subsequent Wires. — Show truck number only.

B — DOWN LOADED TO CLEAR.

Same as « A ».

C — LOADED INWARD.

1st Wire. — Show truck numbers, sheets, etc., and approximate hour of release.

Subsequent Wires. — Show truck numbers only any alteration in approximate hour of release.

D — PARTLY LOADED OUTWARD.

1st Wire. — Show truck numbers, destination, sheets, etc., necessary, and approximate hour of completion.

Subsequent Wires. — These trucks not to be included under « D » in subsequent wires unless any alteration in approximate hour of completion.

E — EMPTIES.

1st Wire and Subsequent Wires. — Show each truck number separately and total number of sheets, ropes and chains.

F — EMPTIES ALLOCATED TO STATION OR SIDING FOR LOADING.

1st Wire. — Show separately each truck which has been definitely allocated to the station or siding for loading, also total number of sheets, etc., allocated.

Subsequent Wires. — Ditto, until loading has commenced.

G — TRUCKS REQUIRED.

1st Wire. — Show each truck separately unless two or more will be identical in type, traffic, destination and date.

Subsequent Wires. — Particulars not to be repeated but reminders and inquiries, etc., to take form of separate letters or telegrams.

H — CANCELLATION OF TRUCK REQUIREMENTS.

Show same particulars as in « G » as soon as any order for a truck is cancelled.

GENERAL.

Inwards laden trucks must not be loaded outward without consent of controlling depôt.

Loaders must be encouraged to give ample notice of their requirements.

The controlling depôt will mark off allocated trucks against stations' individual requisitions, and should loading not be commenced at anticipated time, the autority of controlling depot must be sought before using truck to meet another order.

All trucks must be shown in the morning and afternoon position advices to controlling depot, but trucks under headings « C » and « D » will only be repeated in the clearance wires at the other hours laid down under circumstances shown in above notes.

Truck numbers under « E » and « F » must be repeated in all advices.

TABLE 2. — **Headings of rolling-stock Control Advice.**

R. S. Control Advice.

From .....

For ..... *Date* ..... *Time* .....

A

Truck number.	Destination.	Gross tons.	Class of traffic.	Sheets, chains, ropes.

B

Truck number.	Sheets, etc.	Approx. Hr. ready.	Truck number.	Sheets, etc.	Approx. Hr. ready.

C

Truck number.	Destination.	Sheets, etc.	Approx. Hr. ready.

D

Truck number.	Truck number.	Sheets.	Ropes.	Chains.

E

Truck number.	Truck number.	Sheets.	Ropes.	Chains.

F

No.	Type.	Traffic.	Destination.	Date reqd.

G

H

other, and advise the sub-controls of the loaded and empty vehicles going forward.

Among the reasons for adopting this method of sub-control, which has given very successful results, may be mentioned the fact that in the country districts a great deal of loading is performed at different seasons by farmers themselves, at crossing loops and sidings where not staff is on duty. Many of these places are equipped with telephones which enable the farmers to get into touch with the stations on either side, and also with the sub-control (but not with the divisional office). Orders for trucks are recorded, and information given to farmers as to date time the vehicles will be placed at their disposal.

The empty trucks are labelled with the names of the loaders for whom they are intended before being despatched to the unattended sidings. More intensive interest on the part of depot station staff in rolling-stock matters is engendered by giving them full responsibility for supplying and clearing stations on their sections.

By use of these methods distribution has been made more equal, and the knowledge of loaded trucks in transit obtained under this system is used to such advantage that at harvest and other busy periods the outstanding orders for trucks have been reduced by at least 50 % from the pre-control figures. There is a reduction in time trucks are waiting clearance, and « cross working » of empties, formerly often not avoidable, is now practically unknown. All stations on the division are notified by circular from time to time of the « policy » to be followed, such as loading particular types to certain districts.

Staff and telephonic methods.

No additional staff is provided at sub-control stations, the stationmasters being able to attend to distribution of rolling-stock more accurately and in less time with the boards than with the large printed forms previously used. Except in one or two instances all stations in each sub-control area use the speaking instruments for communicating with the depot station, it being the exception to use the telegraph. Prior to control it was the practice to send a daily rolling-stock code telegram, so that on Division 1 alone a sum of over £2 000 per annum has been saved in cost of telegraph work, which, in that division, was then in the hands of the postal department.

During periods of general shortage on Division 1 the rolling-stock section of the trains office, situated in an adjoining room, is consulted, and arrangements made which suit the needs of the moment, such as facilitating despatch of shipment wool for which boats are arriving, or loading of grain in districts where the grain sheds are reported full, and bagged grain is stacked in the open, etc. Consideration is given to engine power at the disposal of the sub-controls in order to avoid light loading of trains. A detailed description of the Divisional Control Office at Cape Town is given later.

Divisional rolling-stock control methods : Division 2.

Divison 2 has its headquarters at Kimberley, and embraces the area between De Aar in the south and Bulawayo in the north, and Klerksdorp in the east. The whole of the rolling-stock distribution and movement, except that between Mafeking and Bulawayo, is controlled from the divisional office, on information received from stations by telephone and telegraph at 2.30 p. m. daily in the form illustrated in table 3. The particulars are summarised in a statement collating the individual advices.

Supplies and clearances of trucks are arranged by « pick up » trains on in-

TABLE 3. — Telegraphic report of goods and live-stock vehicles used in Division 2.

S. A. R. — Telegraphic report of goods and live stock vehicles.

Summary of goods and live stock rolling-stock, tarpaulins, ropes, and chains on hand AT STATION AND IN DISTRICT at 2.30 p. m.

Telegraphic matter printed in **Block Type** for signalling purposes.

Prefix STR or XTR Code ..... (as the case may be), STATION FROM..... TO.....	Received at..... m. From..... By.....	Sent at ..... m. To..... By.....	Number of message.	OFFICE STAMP.

See explanatory notes below.

	Hoppers.	Bogies (60 000 lb. capacity and over, not dropsided).	Bogies (under 60 000 lb. capacity not dropsided).	Dropsided bogies.	Short goods under 13-feet wheel base (not dropsided).	Short goods, 12-feet wheel base, non-hand brake or six-wheeled (not dropsided).	Short goods, dropsided (under 13-feet wheel base).	Covered goods.	Bogie cattle.	Short cattle (open) 13-feet wheel base.	Short cattle (covered), 13-feet wheel base.	Short cattle (open), under 13 feet wheel base.	Short cattle (covered), under 13-feet wheel base.	Sheep (not dropsided).	Dropsided sheep.	Refrigerator bogies.	Insulated bogies.	Refrigerator shorts.	Meat wagons.	Fruit and perishables.	Fish.	Explosives.	Bisulphate, short.	Bolster.	Flat sideless bogie.	Horse box.	Well wagons.	Goods van, bogie.	Goods van, short.	Water tanks.	Ballast trucks (not dropsided bogies).	« Local » truck.	Sheets.	Ropes.	Chains.
	A	B	C	D	E	Ez	Eze	F	G	H	Hz	I	Iz	J	K	L	Lz	M	N	O	P	Q	Qz	R	S	T	U	V	W	X	Y	Z			
(1) **Inladen**....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
(2) **Empties**...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
(3) **Required**..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
(4) **Spare**.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

(GQ)

(1) This refers to inwards loaded trucks at stations (or in district) which are still under load at 2.30 p. m.

(2) Total number of empties, sheets, chains, and ropes on hand at stations (or in district) at 2.30 p. m.

(3) Requirements for next day's loading *in addition* to trucks on hand; that is, this item must not include any trucks already shown under (1) or (2), nor in the case of Depot wires should it include any on hand in the district which can be moved to point required in time to be of use; *e.g.* A shows E^3 required. If B, a station in same district, has E^2 spare which can be worked to A in time to be of use, additional requirements should be shown as E^1.

(4) Spare trucks, sheets, chains, or ropes are those which will not be required at stations (or in district) during next 24 hours, and will available for distribution to other districts. If any are being held to meet subsequent requirements this should be stated.

GQ or blank space at foot of form to be used to show trucks required for subsequent special loading — giving station requiring trucks, class of trucks, and approximate date — and any other matters which may require to be mentioned.

NOTE. — Details of « Spares » shown against (4) must be given below, showing were standing, *e.g.* Spares at Depot, 1D 3E; West, 5H; East, 2J; North, 1C; South, 2J.

(For further instructions regarding preparation of this telegram, See Special Notice No. 885.)

structions from the Control Office to train starting depots. Boards are not used at the divisional office.

Divisional rolling-stock control methods : Division 3.

The whole of Division 3, controlled from the Divisional Superintendent's headquarters at Port Elizabeth, reaches to De Aar in the north, Port Alfred in the east and Mossel Bay on the west. It has two border stations with Division 4, *viz.*, Cookhouse and Rosmead. The information received and action taken are similar to that in Division 2, but instead of summarising on a statement, the rolling-stock position is visualised on a board.

Divisional rolling-stock control methods : Division 4.

Division 4, with headquarters at East London, includes the eastern side of Cape Colony up to the borders of the Orange Free State. The division covers 993 miles and includes 137 stations and sidings. Movements and distribution of rolling-stock are controlled from East London with the assistance of two sub-control offices, one at Queenstown and another at Burghersdorp. The information furnished by stations is very similar in detail to that obtaining on other divisions, but the boards for visualising the position are of different design. The names of stations are painted in geographical order with groups of pins opposite the names, the groups being headed « Inladen », « Empties », « In transit » and « Staged ». Detailed particulars are received twice daily, from the individual stations in the neighbourhood of East London, and summarised particulars from the sub-controls, when metal discs are placed upon the pins opposite the names of the stations concerned. Different coloured discs represent types of trucks, and the quantity of each type at a station is shown by a smaller disc with numerals, so that the colours of the larger discs are not obscured. Vehicles under repair, etc., are shown by discs with a red cross over the type colour (see fig. 3).

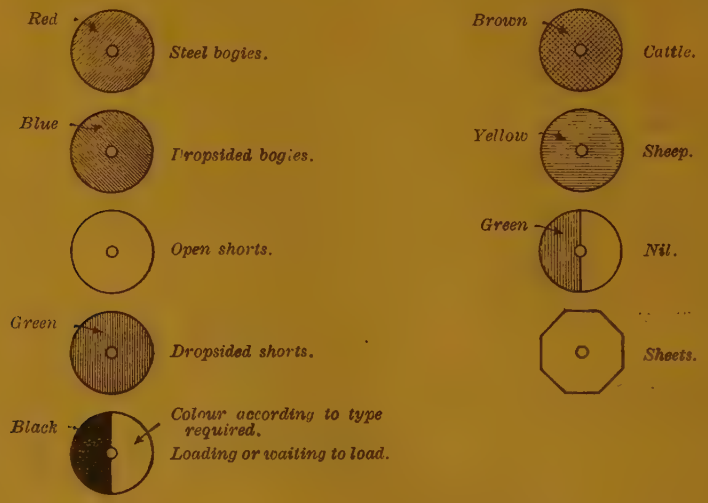
In each of the three areas into which Division 4 is divided certain of the principal depots obtain the required information from the smaller stations in their vicinity and transmit it to the control or sub-control office. It is desirable that the depot stations should know the state of yards on the respective sections operated by trains they despatch, as Control's instructions can thus be anticipated and immediate effect given to them. Various depot and junction stations advise the Control Offices concerned of trucks in transit. The area controlled in detail from East London embraces 410 miles of line. Provision is made at the foot of the control board for summarised particulars from the sub-controls.

Divisional rolling-stock control methods : Division 5.

This division embraces the Orange Free State, the Control Office being at the capital, Bloemfontein. Sub-controls are situated at Kroonstad, Bethlehem and Springfontein. Stations in each of the four areas send particulars of their truck positions once daily at noon, or earlier according to the train service operating on the respective sections. Where possible the information is given over the telephone or « Phonopore »; in other cases by telegraph on forms as used by Division 2. The position is visualised on boards by means of coloured discs similar to those used on Division 4. There are, however, 27 different colours or combinations of colours used at Bloemfontein. Quantities are indicated by small numeral plates of single digits.

In addition to the above, each junction station in the Orange Free State is provided with a control board upon which

full particulars of individual trucks on branch lines are recorded. The junction stations come directly under the respective sub-control offices, and have no authority to distribute trucks. The boards, however, enable junction stationmasters to keep an accurate check on the movements of vehicles and the progress of loading or unloading, and thereby assist the sub-control office to keep rolling-



Special types of trucks such as fruit bogie and short refrigerators are indicated by a white disc with a code letter on top thus :

Quantity discs :

Fig. 3. — Indicating discs used in Division 4 for East London Control Board.

stock on the move, thus ensuring the utmost revenue-earning mileage being procured. The boards at junctions are also of considerable assistance to inspecting offices. It has been found that an efficient and economical control by means of the existing facilities for communication has been obtained, and there has not been any need to appoint additional staff for the work.

Divisional rolling-stock control methods : Division 6.

This division includes the whole of Natal, the headquarters being at Durban.

The control system extends from Durban to Ladysmith, a distance of 190 miles, and is divided into three districts. The Durban district extends to Umlaas Road on the main line and also embraces the north and south coast lines. The Maritzburg district extends from Umlaas Road to Mooi River, and the Ladysmith district from Mooi River to Ladysmith.

Western electric selector telephones have been installed, and to avoid congestion each third station has been joined to the circuit, these stations being responsible for obtaining information from the stations on ether side of them by Phonopore and transmitting it to Control with their own advices.

The train service and truck distribution are arranged from the Control Office upon information as gathered at approximately 7 a. m. and 2 p. m. daily. The Maritzburg and Ladysmith Controls supply summarised information to the Durban Control, and arrange their train service after consultation with the latter.

Visualisation by means of boards has not been introduced. Instead, about 20 different forms are used, and it is upon these that the controllers prepare their instructions to stations.

Engine loads are well watched and percentage of loads to hauling capacity of engines is analysed. The running of the trains is recorded on diagrams, which are passed on to the journal clerks for comparison with the guards' journals so that delays can be investigated. There is a very heavy traffic in shipment coal on this division, for which transport has to be provided, in addition to which sugard refineries and other industries in the coastal area require a large number of trucks.

Divisional rolling-stock control methods : Division 7.

Division 7, the headquarters of which are at Johannesburg, embraces the whole of the Transvaal with the exception of the lines north and east of Pretoria and south of Klerksdorp. An important feature of control work in this division is that of supplying the collieries with large numbers of trucks for loading, principally to the gold mines; also to the coast for export and bunkering purposes. At Johannesburg the position is only visualised upon printed forms.

Yard reports are telephoned or telegraphed to the Control Office at scheduled hours (a specimen of part of one of these forms is illustrated in table 4), which are governed by the times of the « pick up » train service. The chief consideration is that sufficient time is allowed for the position to be summarised and advice despatched to each station regarding distribution; and also for necessary instructions to be issued to guards at starting stations. The schedule of times for reporting has the advantage of distributing the telegraph work and avoiding the congestion which would necessarily follow the retention of a fixed hour for submitting detailed yard reports. Prior to the introduction of the Control summarised reports were submitted by all stations at the same time.

Certain stations are responsible for advising particulars of trains starting from or passing them to « Control » which, with the yard reports, enable the Control staff to issue the necessary instructions regarding distribution.

Divisional rolling-stock control methods : Division 8.

Division 8, which covers the area north and east of Pretoria, controls the rolling-stock from the divisional office at Pretoria. The rolling-stock position is visualised on boards, upon which are stretched wires in sets of seven, representing the seven days of the week. The wires are kept taut in a similar manner to piano strings. The spaces are allotted to stations according to the amount of traffic they usually deal with, and are in geographical order.

TABLE 4. — Specimen of part of yard report as telephoned or telegraphed to Control Office : Division 7.

Truck distribution and clearances : Division 7 standing instructions.

SECTION.	S.T.R 's to Control Office at	« Pick Up » train starts at	Stations to be advised of supplies and clearances and time of advice from Control Office.	Notes on supplies and clearances.
Klerksdorp-Bank . . .	11.0 a.m.	401 ex K. P. R. 1.10 a.m. (ex Mon.)	Klerksdorp, 3.0 p.m.	Requirements not available in section to be supplied from Klerksdorp. Loaded trucks on 400 UP for section to be obtained from Randfontein and included in distribution. Loaded trucks at Klerksdorp for section to be included in S. T. R. and taken into account when supplying requirements.
Bank-Klerksdorp . . .	11.0 a.m.	400 ex B. R. R. 9.15 a.m. (ex Sun.)	Braamfontein, 5.0 p.m. . . .	
Krugersdorp-Zeerust. .	2.30 p.m.	316 ex K. G. R. 8.10 a.m. (ex Sun.)	Krugersdorp (copy B. R. R.), 5.0 p.m.	Empties to be supplied from Braamfontein if not available at Krugersdorp.
Zeerust-Krugersdorp. .	2.30 p.m.	315 ex Z. S. T. 6.0 a.m. (ex Sun.)	Zeerust, 5.0 p.m.	Krugersdorp and Zeerust to include in S.T.R. loaded trucks on hand for section and these to be accounted for in distribution Livetock for clearance by 319 or others. Through trains to be advised direct to Zeerust copy « MOVE «.
Zeerust-Mafeking . . .	2.30 p.m.	...	...	Sections controlled by Zeerust for all supplies and clearances. Control Office to assist as required.
Canada-Evaton.	2.30 p.m.	476/7 ex B. R. R. 7.0 a.m. (ex Sun.)	Braamfontein, 5 p.m.	Drift to include in 2.30 p.m. S. T. R. empties and loaded traffic available for section and these to be accounted for when supplying requirements. Braamfontein to supply any balance required in section.
Evaton-Canada.	2.30 p.m.	1122 ex Drift 6.45 p.m. (ex Sun.)	Viljoens Drift, 4 p.m. . . .	
Springs-Breyten	7.0 a.m. and 4.0 p.m.	677 ex G. M. R. 10.55 a.m. (ex Sun.)	Germiston, 8.0 a.m.	Springs to advise at 7 a.m. and 5 p.m. empties available for 677 and 673, these to be taken into account when arranging supplies from Germiston. Load of 677 to be taken into account when supplying balance requirements in section by 673 and *vice versa*.
		673 ex G. M. R. 1.50 a.m. (ex Sat and Sun.)		
Breyten-Springs	See Notes.	686 ex Bethal 12.30 p.m. (ex Sun.)	Bethal, 10.0 a.m.	Bethal to include in S. T. R. loaded trucks on hand for Bethal-Springs section and these to be accounted for in distribution.
				Kinross, Trichardts and Bethal to submit S. T. R. at 7 a.m. and include final clearances for 686 Up. Endicott, Devon, Leslie, Davel and Estantia to submit S. T. R. at 4 p.m. and include approximate clearances 686 up following day; final clearances to be wired at 7 a.m. 671 down Sundays to be filled up with empties for Breyten, Bethal to work forward 341 down.
Bethal-Volksrust. . . .	See Notes.	Tri-Weekly service. . . .	...	Section controlled by S. M. Volksrust in conjunction with S. M. Bethal. Supplies for Bethal-Amersfoort (inclusive) section to be sent via Bethal balance section to be supplied via Volksrust after accounting for inladen and empty trucks in section.
Apex-Witbank.	2.30 p.m.	807 ex G. M. R. 4.50 a.m. (ex Sun.)	Germiston, 5.0 p.m.	All requirements in this section to be supplied from Germiston, less any suitable empties available for clearance from Apex and Geduld.
Witbank-Apex	2.20 p.m.	804 ex W. I. T. 1.10 a.m. (ex Sun and Mon.)	Witbank, 5.0 p.m.	All spare empties to work to Witbank.

Each truck is indicated by a small round disc of stiff paper or thin card (as used at the back of files of correspondence), and these are placed on the wires with paper fasteners. The truck numbers, and also types in code letters, are written on the discs, as well as the numbers of the trains by which the vehicles reached the stations. Different coloured discs are used to indicate trucks under repairs, or staged for want of engine power, etc., and blue pencil marks signify the progress of loading and unloading (fig. 4), the marks being made as the conditions alter.

Stations telephone or telegraph particulars twice daily (excluding Sundays and holidays), and depot stations supply the Control Office with additional information concerning destination and type

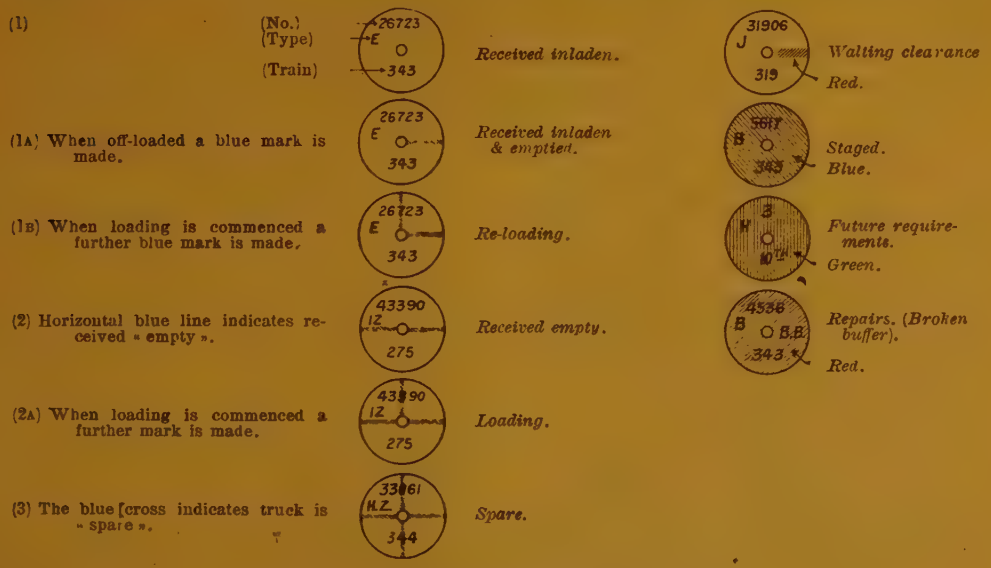


Fig. 4. — Identification discs as used in Division 8.

of trucks on each train despatched. As in Division 7, the telegraph work is in the hands of the Railway Administration.

Truck numbers.

The only Control Offices dealing with individual truck numbers are the divisional office at Pretoria and the sub-controls on Division 1. At the former place numbers are only recorded in the case of the smaller stations. At the sub-controls working under Cape Town divisional office no difficulty is experienced in recording up to 200 individual trucks per day even though the area in which they are moving or standing extends 150 to 200 miles, provided there are not more than about 20 stations in the one sub-control area. The conditions which make it necessary to record truck numbers on these two divisions are exceptional, and details of the use made of the numbers would not be of general interest.

South-West Africa.

The remaining division is that embracing the South-West African Protectorate, where the control system has not yet been introduced.

CAPE TOWN DIVISIONAL CONTROL OFFICE.

The Control Office is situated at the Cape Town headquarters, in a room 37 by 20 feet, adjoining the trains office, and is divided into two portions by an archway. Provision has been made at one end for future extensions. On one side of the arch is accommodation for the clerk-in-charge, and on the other desks are arranged round the room.

The control boards are constructed of green « hylo plate », which has a surface suitable for painting the diagrams, etc., while the colour is restful to the eye. It takes white or coloured chalk, the marks of which are cleaned off easily. Sketch plans of the stations with the usual information, *viz.*, mileage, accommodation of each siding in axles, water columns, turntables, engine pits and weighbridges, etc., are clearly shown; also gradients approaching stations, which in South Africa are often considerable, and the running times between stations of passenger, fast goods, and slow goods trains.

Train indication.

There are holes in the board for insertion of coloured wooden pegs which represent different classes of trains. Small ivorine discs, bearing the number and class of engine, are slipped on to the stems of the pegs. Clips are also fixed to the pegs, and in these are placed the train cards; the movements of trains are recorded on the front and particulars of loads and any intermediate work to be performed are shown on the backs of the cards. The front of one of these cards is reproduced as table 5. The back is ruled as a vehicle list. The desks are cut away slightly to enable the Control clerks to reach the boards without rising from their seats.

Truck indication.

The rolling-stock position of each station is shown on small steel plates, which

TABLE 5.

Train indication card, Cape Town Control.

Cl. of Train. **Date** ..... **192**.....

Train No. ..... **Engine No**..... **Cl.** .....

Engine Depot or Shift .....

Gd ..... Dr ..... F'man .....

Relief .....

On duty ..... off..... *Rlf. on* ..... *off*.....

Stn.	Booked.		Actual.		Remarks.
	Arr.	Dep.	Arr.	Dep.	
C. Tn.					
W'stk.					
S. Rr.					
Obsy.					
Mow.					
Rose.					
Rond.					
Nlds.					
C'mt.					
W'bg.					
Pstd.					
Dp. Rr.					
Rtrt.					
Lsde.					
Mzbg.					
S. Jas.					
K. Bag.					
Fh. Hk.					
20 M.					
Gncn.					
S'tn.					

Remarks :

have been cut out of truck springs recovered from the scrap bank and magnetised. These are fastened to the boards by screws from the back. To secure even adhesion of the discs described below, the steel plates are set out on the board before being magnetised and marked so that the tops and bottoms shall be north and south poles, as the strength would be uneven if the poles were at the ends. The plates do not exceed 6 inches by 2 inches in size and where larger surface is necessary two or more are placed close together but not in contact. The surface area of the plates approximates the capacity of the yards they represent, following the same scale as the printed names of trucks described below.

The trucks are indicated by discs of Swedish soft iron, also recovered from the scrap bank and originally part of electric transformers and dynamos. The names and code letters of the various types of vehicles are printed on sheets of paper in such a manner that each sheet contains a block of trucks proportionate in size to the number of its type in local use (see fig. 13). Each four and eight-wheeled truck occupies a space of 1/2 inch by 1/4 inch and 1 inch by 1/4 inch respectively. The sheets are pasted whole on to the iron with shellac varnish and cut in a guillotine. The small blocks of trucks thus obtained are cut again into required quantities of one's and two's, etc., and stocked in a set of shallow drawers. The discs are used until too soiled for quick recognition, when they are thrown away. They usually last three or four months. When first introduced, several methods of handling the small discs were tried, but after a few weeks the controllers found no difficulty in placing them on and off the magnets without appliances.

Different tints of paper allow of ample distinction between trucks empty and loaded, required and spare, or under repairs, etc., and colours would also serve to indicate ownership, but so far it has only been necessary to use two indications, *viz.*, red for loaded and white for empty. South Africa is fortunately not troubled with many privately-owned vehicles, nor are the foreign companies' trucks on the Union lines in such proportions as to call for distinction. It may be thought that difficulty would arise in changing one or more of a block from red to white or *vice versa*, but this can readily be done by placing a smaller disc of another colour on the top of a portion of a disc already on the board.

In practice it is found that the Control clerks know what is being done, or is intended to be done with every individual truck on their respective boards, in much the same way as a yard inspector remembers his instructions regarding all the trucks in his yard. This method of visualisation is very compact, and is found suitable for the control of large numbers of vehicles. It also has the very considerable advantage of showing the state of congestion or otherwise of the yards under control. The Simonstown Branch, for example, with twenty-four stations accommodating 1 700 axles, is visualised on a board 4 ft. 6 in. by 1 foot, the steel plates occupying about one-sixth of the surface.

Means of communication.

In and around Cape Town there has been for many years an extensive Government postal telephone service on central battery system, and practically every station in the divisional control area is connected to a postal telephone exchange. In addition, signal cabins in the vicinity were connected to Cape Town terminus by omnibus (party) lines. On the Simonstown branch, which is the most important passenger line, Gill selector telephone instruments were installed some years ago.

For the purpose of « train control » a small exchange board was set up in the Control Office, having four lines to the

railway exchange at headquarters, with its 250 « central battery » connections and its 16 junctions to Post Office Central Exchange. There are also two lines direct to the Post Office Central Exchange, direct lines to the principal officers at headquarters (on their domestic inter-communications sets), and to the locomotive sheds, passenger stations, and foremen at all the principal goods yards. All the existing omnibus lines were extended to the Control Office exchange board, together with two additional omnibus lines ordered some years previously, but held up for want of material during the war. Each of the Control clerks has a magneto table telephone, and by a simple alteration the exchange can deal with both central battery and magneto calls, the one system being put through to the other without disturbing the light indications at the central battery exchanges.

To avoid receiving the magneto rings of the omnibus circuits, which are of course in constant use between cabins, etc., the drop shutter indicators for those lines where altered to operate with direct current. This is provided by battery, one side of which is earthed at the exchange. The circuit is completed by pressing an ordinary push button at the station end, one terminal of the button being to earth, and the other terminal divided and joined to lines. Tumbler switches are inserted on the board in the omnibus line circuits in case of earth faults appearing which would cause the drop shutter indicators to remain down.

All the omnibus circuits are metallic return, and outward ringing on them is performed by power supplied from the Post Office Central Exchange. As the converted indicators on the exchange board were earthed, it was found necessary to insert a one to one transformer in the ringing circuit. The wiring for combined central battery and magneto working, earth ringing from omnibus circuits, and for connecting the domestic inter-communication sets, is shown in figure 5.

Spare head and breast sets are provided for the magneto telephones, and jacks wired in parallel are fixed to the small brackets upon which the telephones stand, so that in circumstances demanding unusually close attention on the part of the controller, he can have both hands free for writing, etc.

The exchange is operated by a messenger, who puts calls through to the particular Control clerk who should deal with the section or subject, or to a colleague if the one required is already engaged. This system is also very useful for avoiding waste of time on the part of Control clerks who would otherwise have to get through two or three exchanges in many cases, and perhaps find the numbers engaged, or the person wanted not available for the moment. The exchange attendant is merely told by the Control clerks whom to ring up, and is generally busy putting through five or six different calls. He keeps any of them on the line if the Control clerk who initiated the call is conversing with somebody else.

The postal department allows the Control Office priority of trunk line calls, both inwards and outwards, for dealing with engine failures and washaways, etc., and priority is given whenever asked for on the railway department's own exchange. The omnibus circuit users have instructions to give Control precedence in all cases except cabin to cabin messages *re* train movements, which are necessarily brief. Every endeavour is made to keep the Control Office quiet. Bells have been removed from telephone instruments, matting laid on the floor, and the Phonopore instruments connected to the distant sub-controls are placed in a silence cabinet.

In addition to the postal telephones and omnibus circuits there are two selector telephone circuits. The Simonstown branch, 22 1/2 miles, with 24 stations, has a Gill selector. The portion

of main line from Cape Town to Worcester, 109 1/4 miles, has 20 stations and cabins connected to a Western Electric selector of the latest pattern, using alternating current for the selective calling. This is a very efficient piece of apparatus, and speaking and ringing are both excellent. These instruments have been described in the pages of the *Railway Gazette*, but what may probably be a unique feature is the mounting upon small turntables, with the wires running

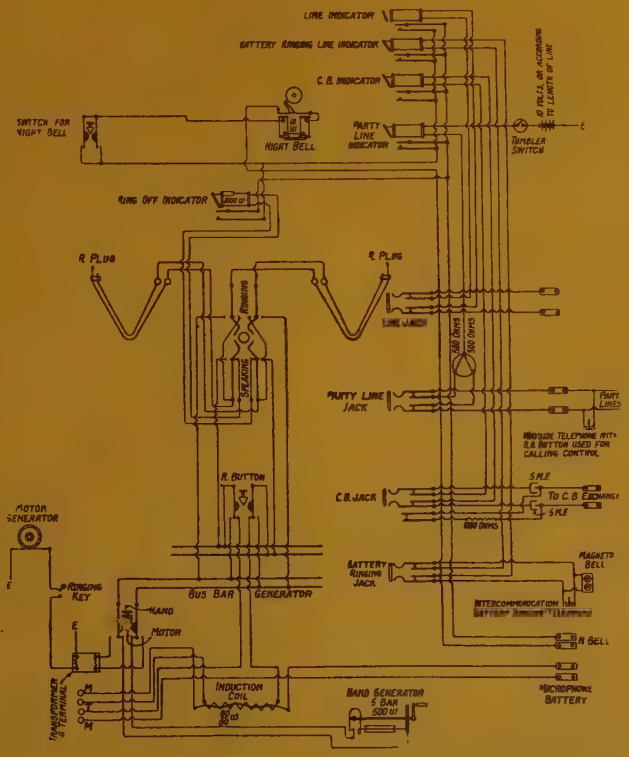


Fig. 5. — Arrangements of circuits on 25 line magneto telephone switchboard, Cape Town Control Office.

through the centres of the turntables. The instruments can thus readily be used by the clerks sitting on either side.

The circuit is of 200-lb. copper wire, and the lines transposed every half-mile to prevent induction. Small test boxes with a couple of U-links are mounted on the station instrument back boards, and printed instructions for a simple test are pasted alongside. Line faults, or instruments out of order, can be localised very quickly by the controllers, and advice sent to the nearest linesman at once. The stations on the Cape Town-Worcester section are from 5 to 10 miles apart.

Time-keeping.

Each of the controllers has a small electric « pulsometer » clock in front of him, the half-minute impulses being received from a master clock which

operates all the clocks at the Cape Town terminus. Hourly current from the Royal Observatory, about 3 miles distant, serves to regulate the master clock. The suburban station clocks have hourly regulation by electric current, and all other stations receive a daily time signal.

Methods of working.

The Cape Town divisional office combines detailed train control and rolling-stock control over the stations in its vicinity. The methods of train control are very similar to those employed in other countries, but the rolling-stock control described above probably includes some novel features.

On the Cape Town-Worcester section each station advises the movements of all trains and the controller moves the corresponding pegs and inserts times on the train cards. Yard positions are telephoned twice daily in similar form to that used for the sub-controls, but without truck numbers. Clearances of traffic are arranged from the Control Office, the depot stations being instructed to leave room or to attach certain traffic which will, when put off at destination, permit of picking up a pre-arranged tonnage at particular points *en route*.

Guards of pick-up trains are furnished with forms detailing the work their trains are to carry out. Control advises stations which trains are to pick-up or put off traffic, and also the quantity of transhipments to be put out, thus affording staff at wayside stations opportunity for arranging suitable meal hours. Particulars of train loads are received from the starting point at each end of the controlled section, and also from sub-controls in respect of branch line trains working towards the main line, and the details are recorded on the backs of the train cards.

The Control clerks move the discs representing trucks on and off the magnets as trucks arrive at or leave the stations, thus having a visual representation of the actual position at each of the yards which are under its direct control. The telephoned details of yard positions serve as a check upon the board details, and show whether Control's instructions have been carried out. As few forms as possible are used, but the summarised information from sub-controls has to be recorded.

Trainsmen's reliefs.

When it is seen from the boards that trainsmen have been on duty long hours, steps are taken to send relief, and the men are advised where they will relieved. If this is not possible some of the work which the late train should perform is given to other trains, and the progress of the late train accelerated by this and other means.

Shunting engines.

The work of shunting engines employed in the goods yards in the vicinity of Cape Town is closely watched and advantage taken of any quiet moments to run short trips with traffic which can thereby be placed into position for unloading or, if loaded outwards, can catch an earlier train to destination than would be the case if left for the ordinary goods trains to deal with.

Special train arrangements.

The running times and announcements of special passenger, goods and ballast trains are arranged in the Control Office, and the engine working and guards' working is also arranged by the Control staff in conjunction with the depot officials.

Supervision of enginemen.

Should an engine driver lose time or reduce load on account of locomotive trouble the Control staff advise the Assistant Superintendent (mechanical) by telephone, so that arrangements can be

made to have the engine met and examined on arrival and before the driver signs off duty.

Suburban passenger trains.

The suburban trains on the Cape Town-Simonstown branch carry about 80 000 passengers a day and during the rush hours arrive at or leave the terminus at intervals of 2 or 3 minutes. No control is exercised over these trains unless an engine failure or other circumstance is likely to affect the running. In such cases « Control » is immediately advised, and, with the aid of the train diagram inset in his desk and illuminated from below, and upon which is shown all the engine link and the platform working, the controller issues instructions for the purpose of getting passengers to their destinations with as little delay as possible; and also takes steps to have any breakdown or obstruction cleared promptly.

On a recent occasion a collision just before the lunch rush hour caused a block of both up and down suburban lines 16 miles from Cape Town, but the service was so operated by the Control staff that passengers on the near side of the obstruction were not aware of the accident until they read of it in their evening papers, while those travelling to and from the far side of it were not delayed on the average more than about 10 minutes.

Public holiday train service.

On public holidays, when large numbers of people, up to 20 000, visit the coast resorts on the Indian Ocean side of the Cape Peninsula for the surf bathing and other attractions, special train services are in force. These are always controlled, and certain stations advise the departure or passing of every train. Stationmasters inform « Control » when the trains are becoming crowded, or are not well filled, and the controller alters stopping trains to expresses and *vice versa* during their journey, and to suit the needs of the moment. Additional trains are run where required, but the lines are so fully occupied that this can only be done as a rule by altering the running times of others laid down in the holiday schedule. It is in such circumstances that a control system shows its unique advantage in operating matters. Instructions are conveyed quickly to the persons concerned at stations affected by the alterations, and it is not difficult to ensure that the servants who should know are advised, without burdening others with details which do not immediately concern them.

Suburban goods traffic.

It is with the suburban goods traffic, however, that the « Control » has so far shown its influence to the greatest advantage. The suburban stations are from about 1/2 mile to 3 miles apart, yet each has its goods yard, a relic of the days when most of them served separate villages and fast moving road transport was unknown. As in England, such suburban yards are still used for short distance low-rated traffic such as coal, bricks and forage, etc., and owing to lack of space the sidings in these yards have not been lengthened to the same extent as development of locomotives has lengthened trains. Prior to the introduction of the control system loads of suburban goods trains had to be much below engine capacity, so that these trains could quickly move out of the way of passenger trains and could be shunted into short sidings.

The goods trains run at night, but as passenger trains are moving 20 hours out of the 24, goods trains are bound to get into the rush at some part of their journey. As in other parts of the world, the signalmen have been drilled into preventing delays, or even signal checks, to passenger trains, consequently the

goods trains were frequently side-tracked for hours.

The Control staff now handle the goods trains, which are run with full loads, and give instructions to side track or despatch according to opportunities of the moment. If necessary, trains are ordered to overcarry vehicles past destination, and put them off on the return trip, such factors as the opportunity for crossing the opposite road to reach the yard, the amount of traffic already in position for off-loading, the opportunity for shunting at stations ahead, traffic to be picked up at points ahead for the station which it is decided to run through, etc., being considered.

Train diagrams.

Both single and double line timetables are arranged with the aid of train diagrams (graphs). The whole of a main line section diagram is shown in figure 6. Each of the controllers has a copy of the diagram affecting his section inset into his desk under a thin piece of ground glass, upon the surface of which he can pencil any altered working he proposes to make. Many of the smaller stations are closed during certain hours, such hours being indicated on the diagrams by means of a pale colour wash which allows of the information being read through it. Coloured inks are used to indicate different engine links on some diagrams, and for trains to various branches, or for certain classes of trains, on other diagrams.

One of the main line controllers also has a blank diagram form and pencils the actual running. This visual reflection of the position, together with the information on the board, enables him to advise stations which trains to hold back and which to push forward to make good crossings on the single line. It is obvious that from the information in his possession regarding loads, engines, trainsmen, and work to be done, etc., the controller is in the best position to decide upon precedence of trains. His outlook is less circumscribed than that of the stationmaster at any one station, and, however intelligent and zealous the latter may be, the controller has the better opportunity to decide upon a course which will be to the greatest advantage of the service as a whole.

It has always been the practice to diagram the actual running of the trains with a view to investigating delays, etc., but this was formerly done from the guards' journals a day or two after the trains had run.

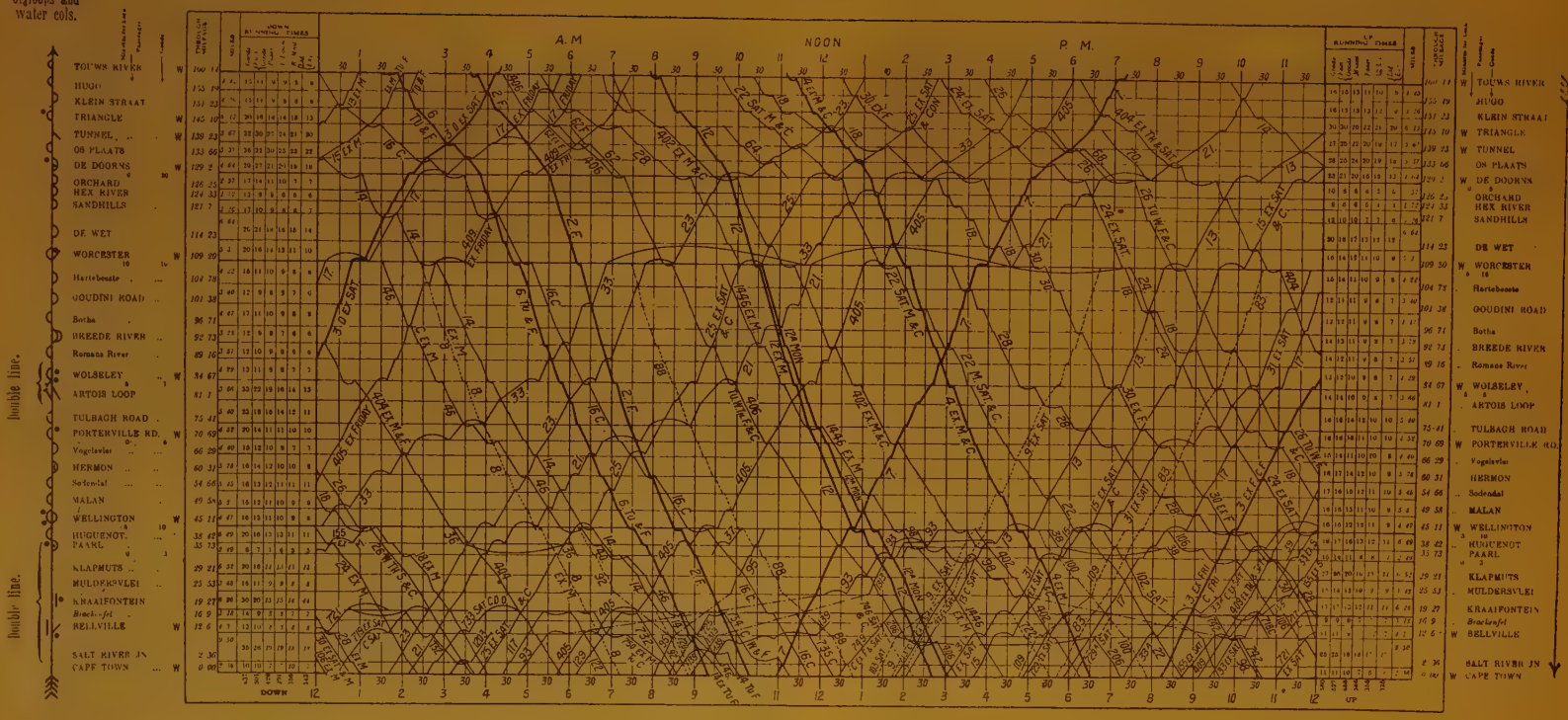
Goods train connection calculator.

To facilitate calculations as to probable time of arrival of any truck at its destination, a « train connection calculator » has been devised. This is illustrated in figure 12, and shows at a glance the connecting trains for goods traffic to and from any branch or part of the main line on Division 1.

Estimated tonnage board.

There is also a board (figs. 9 and 14), upon which the estimated tonnages are recorded under each section served by certain trains. The approximate gross tonnages are furnished by stations or sub-controls when ordering trucks, and consequently reflect the tonnage which will probably require moving at the end of the next 24 hours or more. The tonnages for 24, 48 or 72 hours ahead are shown in different coloured chalks. As an instance of its use, it may be stated that the Caledon sub-control, when ordering trucks for Klipdale to load, knows that these will not be back again at the junction for movement to their final destination within 72 hours from time of ordering, whereas trucks ordered for another station should be at the junction within 48 hours.

As the information is received, small bone pegs are moved up the columns and inserted into holes against the print-



REFERENCE.

Through passenger trains. . . . . ———————

Mixed and local passenger trains . . ----------

Goods trains . . . . . ———————

Via Stellenbosch branch . . . . . ———·———·———

ENGINE AND TRAINSMEN WORKING.

Cape Town-Wellington. — 159/98, 93/92. (Except Mons. 90 Suns. 101 Suns/92, 97/102, 109/106, 95/100 (Men book off at Wellington for rest).

Cape Town-Worcester. — 21/8, 9/88, 83/1446, daily except Suns , and Mons., Men of 83 on Sats., to return spare 12 Suns. Spare set of men 3 Suns., to work 28 Mons., 31 except Sats., and Sun ./28. 33/18.

Worcester-Touws River. — 21/18, 33/28.

Cape Town-Touws River. — Relieved at De Doorns. 15/402, 17 Suns., Frids. and Sats./22 Mons. Sats., Suns., 17 Mons. Tues., Weds., Thurs./4, Tues., Weds., Thurs., Frids., 409/30, 23 Tues., Weds., Frids./26, 25/404, 405/14, 13 Mons , Tues., Weds., Thurs./406, Tues., Weds., Thurs., Frids.

Through Working Cape Town-Touws River. — 13 Frids., Sat./4. Sats and Suns.. 23 Sats., Mons , Thurs./6, Suns., Tues , Frids., 1213 Cond. Sun./4 Cond., Mons., 3]24 (Sun.. 14), 7/12, 25 Thurs., 2 Frids., 15 Cond., Sats./404 Cond., Suns.

Triangle-De Doorns. — No. 62, 64, 68 and 70 trains worked by De Doorns banking engine are required.

Fig. 6. — Train diagram : Touws River and Cape Town section, South African Railways.

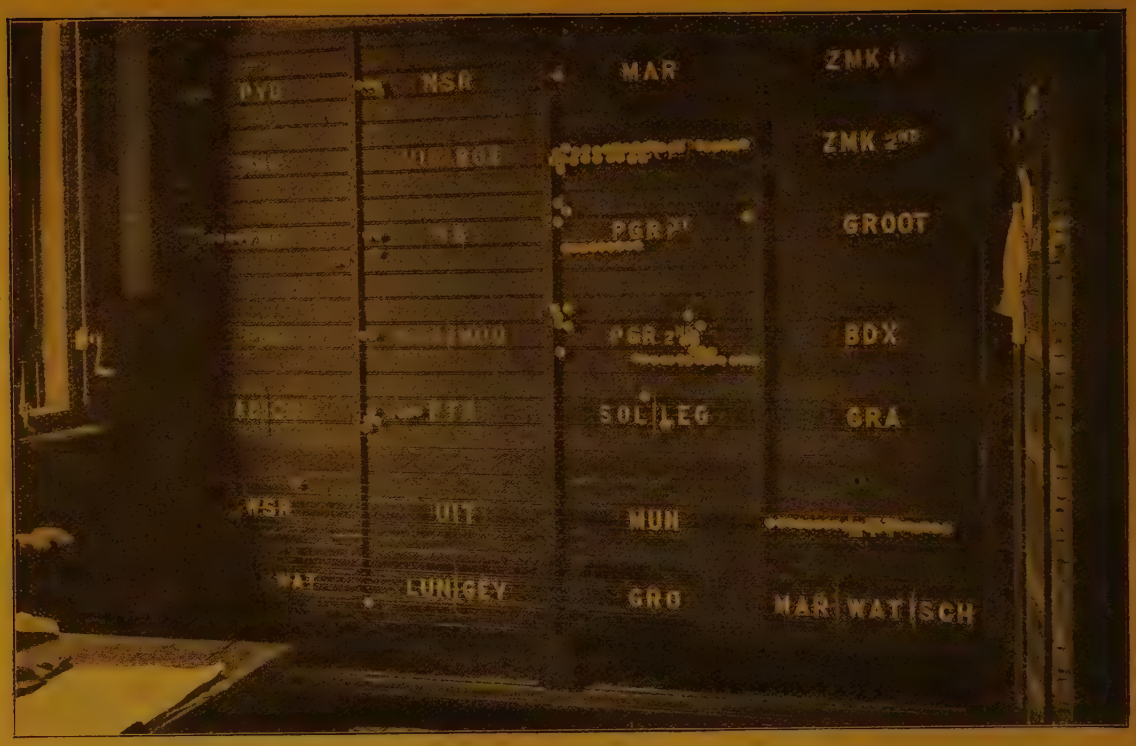


Fig. 7. — Rolling-stock control board in use at Pretoria.

Fig. 8. — Control desks, Bellville-Worcester section, Cape Town divisional Control Office.

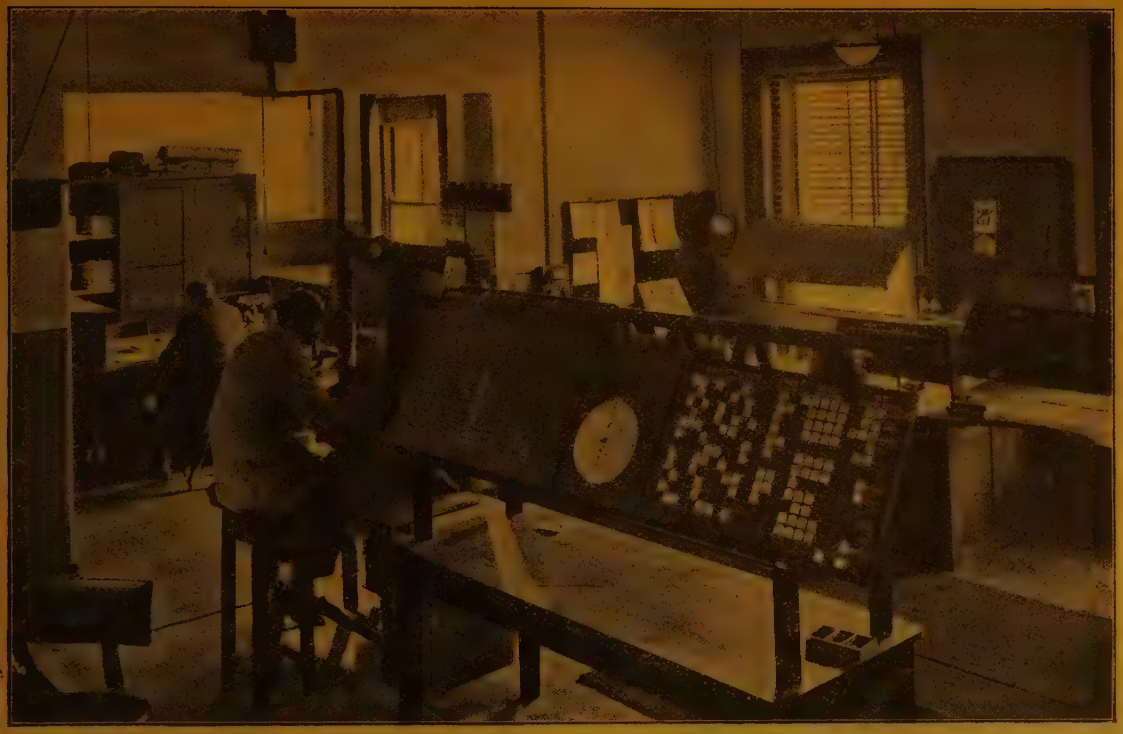


Fig. 9. — General view of Cape Town Control Office, showing position of control telephone exchange.

Fig. 10. — General view of main line side, Cape Town Control Office.

ed figures representing progressive totals. In the illustration, the first column shows that, for the train starting at 8.30 a. m. the following day, and

Fig. 11. — Western Electric selector telephone on turntable.

Loud-speaking call device mounted on top and only in circuit when head and breast sets have been taken off operators temporarily.

Magneto telephone on control exchange circuit is screwed down to small braket in front.

which will serve the stations between Salt River and Bellville, Cape Town docks are loading 15 tons, Cape Town goods 60 tons, the Simonstown branch (taken from particulars on the Simonstown board) 15 tons, the Stellenbosch loop section 20 tons, and the Caledon section 11 tons, making a total of 121 tons. The peg stands against the figure 120 until further advices are received.

At about the middle of the board is a horizontal red line, at which level the printed tonnage figures equal the average load of a train according to the usual class of engines on the respective sections. Consequently when the pegs are above the line there is more, and when below less, than a normal train load. No notice is taken if the pegs are slightly above or below the red line, but should any of them go well above or remain considerably below, steps are taken to confirm the information and instructions given to increase or reduce

Fig. 12. — Goods train connection indicator, Cape Town control.

the engine power accordingly. Allowing 12 hours for obtaining confirmation, there is still a margin of about 12 hours in which to advise the locomotive depots — a margin which allows of economical re-distribution of the engines and men.

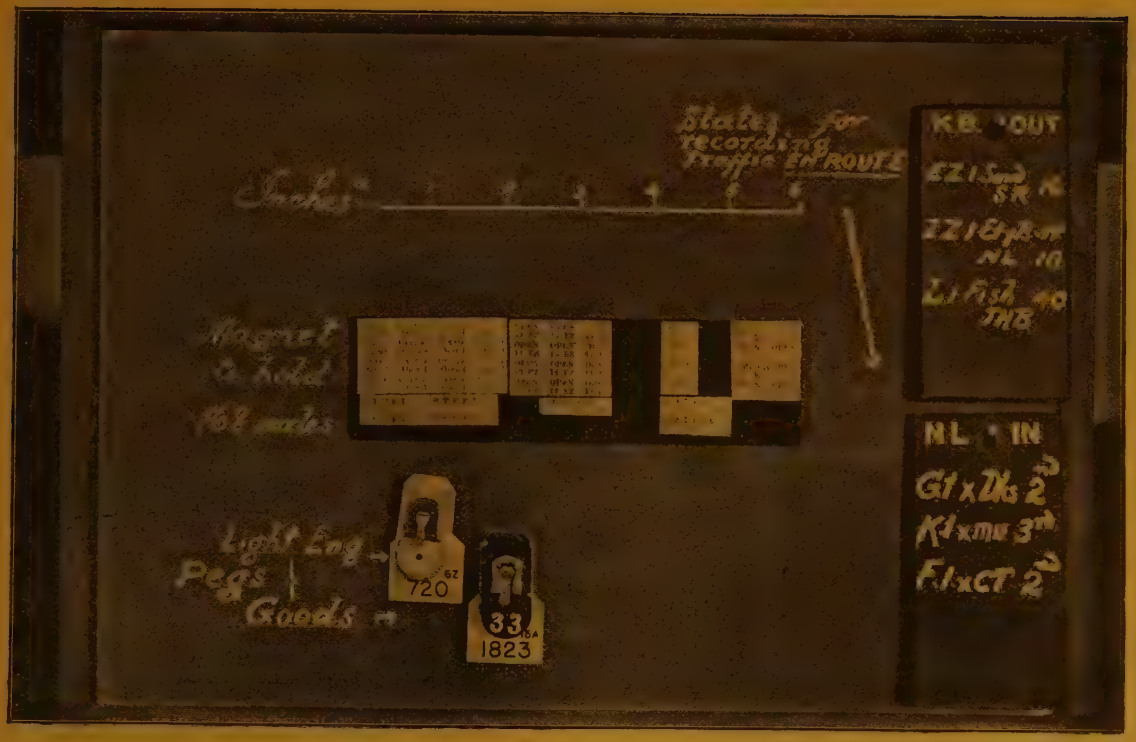


Fig. 13. — Scale illustration of (1) truck indication, (2) train pegs with clips for cards and « slip on » engine discs, (3) slates for recording traffic « en route ».

Fig. 14. — Estimated tonnage board (left), and engine position board (right), Cape Town Control Office.

Card index of trucks.

The whole of the Union railways goods stock is indexed on the « Acme » card system, every available item of information about a vehicle having been collected from various sources and included on the cards. This is conveniently placed so that any of the controllers are able to refer to it and ascertain in a moment the tare, carrying capacity, cubic capacity, length and size of doors, etc., of any given truck.

Engine position.

The engine position is reflected upon another board (figs. 9 and 14) and is altered daily upon information received from the Mechanical Superintendent's office. This assists the clerk-in-charge to make his plans for running any additional trains required. As engines are detailed by the locomotive depot for various trains, the train numbers are pencilled on the backs of the ivorine discs, which are then passed to the respective controllers to be placed on the peg when the departure of a train is reported.

Passenger train arrival board.

A small board marked « Main Line Trains » [which will be noticed in one of the illustrations] has recorded upon it the advices received from depot stations regarding the running of the long distance passenger trains from all parts of the sub-continent. The information first appears when the trains are 24 hours away from Cape Town, and the board is in a position for all the office staff to see, because, constant inquiries are received by telephone from suburban stations and from persons who have friends to meet, etc.

Traffic « en route »

Referring to figure 13, showing a scale illustration of the slates used for recording traffic *en route*, it should be stated these are made of « hyloplate », green on one side and black on the other. They are placed on hooks at the bottom of the boards under the respective stations, and at the time the illustrations were taken were only used on the Simonstown branch board but have since been extended to the others.

Traffic which will be ready for despatch by the time the pick-up train arrives is recorded in chalk on the « out » side, and the information transferred to the respective controllers who record it on the « in » side of their slates under the stations affected; the date the traffic should arrive being shown also. The despatch of empty trucks to stations for which suitable loaded types are *en route* is thus avoided, and prospective congestion can also be foreseen.

Lighting

No special arrangement of windows for day lighting was possible, and top lighting was out of the question because of two floors of offices above the control room. At night the office is lit on the « holophane » system, the light being soft and uniform all over the room.

Improvements in running.

Detailed statistics have been reduced greatly since the beginning of the late war, and, without going to very great trouble, it is not possible to extract figures for the sections over which train control has been introduced from the statistics dealing with such a huge undertaking as the South African Railways.

The following information is, however, compiled from information which has been regularly recorded for departmental use for very many years, *and has not been obtained from the Con'rol Office.*

Cape Town-Simonstown (suburban) line.

Comparing the first six months of control with the average working for

four months immediately prior to control, the improvement obtained is as follows :

	Decrease of goods train mileage.	Decrease in total trainsmen's hours.	As against difference in tonnage hauled.
1st month.	8.7 %	20 %	18 % decrease.
2nd —	22.13 —	22 —	24 — —
3rd —	31.37 —	25 —	7 — —
4th —	28.88 —	34 —	4 — —
5th —	36.02 —	35 —	Nil.
6th —	35 —	31 —	8 % increase.

Cape Town-Worcester (main line) section.

The data for this section are not easily obtained, having to be abstracted from details for a larger section. Comparing November 1921, the last month for which the controlled section figures have been so abstracted (at the time this article was compiled), with May 1921, which was the most recent pre-control month not affected by washaways, there has been an increase of 42.3 % in the average tonnage hauled by each pick-up goods train. Notwithstanding the extra work these trains have coped with, the average running time was reduced by approximately half an hour on an 8-hour schedule.

The average loads of through goods trains showed an increase of 10.8 % and there was a reduction in running time proportionate to that of the pick-up trains, but on a faster schedule. These results have been obtained on a section where the pre-control working was of a highly efficient order.

Information for administrative staff.

Each controller has a manifold book in which to record brief particulars of accidents, delays, or other happenings requiring administrative action in various sections of the head office. The controller records the incidents as they occur and immediately send the carbon copy to the office concerned. It is the controller's duty to obtain sufficient information to permit of necessary action without preliminary correspondence. A brief summary of the principal events of the preceding 24 hours is placed upon the desk of the Operating Superintendent each morning; that officer also being kept informed of important matters at the time of their occurrence.

Control staff.

As a tentative measure the Control Office has been staffed with clerks who became spare by reason of the work being reduced in other sections of the operating branch on the introduction of control, and some assistance has been obtained from the relief staff. Steps are being taken, it is understood, to provide a standard control establishment to be composed, as far as possible, of men who have had outdoor and station experience. The work of the controllers comes under review, and action is taken to secure improved results where this is necessary.

There is a total staff of 10 including one clerk-in-charge, two shifts of three clerks, and one shift of two clerks, with one additional clerk on day duty who relieves for meal intervals and assists generally. The shifts are divided into 8 hours.

The underlying principle of the conduct of operations by the Control staff is that the running men and those employed on station duties may realise there is a spirit of co-operation and assistance in the control system, and not one of inconsiderate dictation. Expression of opinion from supervising officers and from stationmasters have been unanimous in their appreciation of the practical benefits of the system.

[656 .255 (.42)]

Switching-out single line token instruments,

Figs. 1 to 6, pp. 298 to 300.

(*The Railway Gazette.*)

The switching-out of signal-boxes at night, on Sundays or at other times on double lines of railways, is readily performed. The bell signals and block indications sent by A to E when boxes B, C and D are closed are similar to those which A sends to B when the latter is open. The signalman at E during the same period signals and indicates to A exactly as he will do to D when the latter is open. The block instruments are of the same pattern, and the operating of a device such as a switch at each of the intermediate boxes cuts out the instruments and connects the wires on either side so that there is through communication.

Switching-out intermediate sections is a very different proposition when applied to token working on single-line railways. Each single line section is self-contained, and the tokens controlled by the instruments for a section apply to it alone. A train may not be taken beyond B to enter the BC section with an AB token. Obviously to close B means an extended section AC, which must not be operative until sections AB and BC are closed against sectional working. That being made possible it is clear that, if necessary, C also may be closed and the section become AD; or C and D as well as B may be closed and the section become AE. In fact, any number of token stations may be switched out and long section working established between the extreme points by the means described subsequently.

Difficulties hitherto prevailing.

The switching-out of intermediate stations on single lines is not a new idea, as various methods of accomplishing this have been tried. Hitherto, the arrangements have not altogether been satisfactory. For instance, difficulties have arisen where there have been two or more consecutive sections to switch out. Some of these arrangements have required a train movement to precede switching-out. As a consequence, the non-running of the intended train has prevented the closing of the station, or its late running has delayed the same. Other methods have necessitated this final modification to be made in a given predetermined direction, *i. e.*, always by either a train in the up direction or a train in the down direction. Conversely, it was requisite under such arrangements for a train in the opposite direction to re-open the station, and then, under the conditions instanced, a train in one direction may be delayed until a train in the opposite direction has gone through the long section.

Another obstacle that formerly existed was that a train, arriving at a station, could not, on account of the locking frame being secured for through running only and the points being locked for this through running, detach or pick up vehicles at that station whilst it was switched out.

By the switching-out arrangements designed and patented by some of the

officers of the London Midland & Scottish Railway Company in conjunction with the Railway Signal Co., Ltd., these difficulties, real or anticipated, no longer have any justification.

Any number of token stations may be switched out and there may be on a stretch of single line one or more long sections. All that is necessary is one pair of additional instruments for controlling each long section, an intermediate control at each station which has to be switched out, and a terminal control at one of the two extreme stations of each long section.

Before proceeding to describe the apparatus used for this purpose, it is desirable to remark that whilst the electrical train staff is used to illustrate herein the method employed, the same end may be obtained by practically the same means with other forms of electrical token working. The arrangement can, moreover, be made to apply to a combination of the various types of electrical token systems.

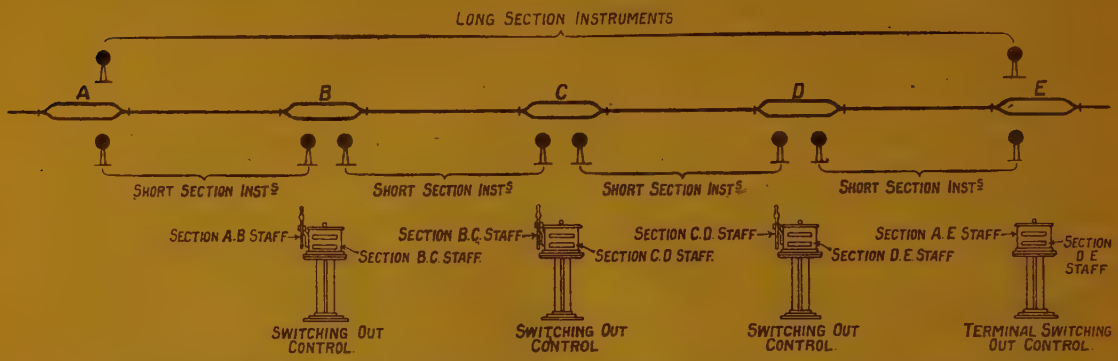
Passing loops to be dual-directional.

In switching-out intermediate boxes that are passing places, a matter to arrange is, that one of the passing loops must be used for trains in either direction, instead of one loop for up trains and the other loop for down trains. The former method of working is generally not adopted when the box is open, as the interlocking compels trains to take the left-hand road. When the cabin is switched out, all trains must use a predetermined road — either the up loop or the down loop — and interlocking must be brought into operation that will allow this to be done so that such movements shall be made as secure as when running over the usual road. Moreover, long section working must not be allowed to operate until the roads are properly made for this one predetermined direction, and when brought into use the points, point locks, etc., must be suitably interlocked. Also, if desired, the signals can be back-locked to suit and be immovable until short section working is ready to be restored. All these conditions have satisfactorily been provided for in the scheme now under notice.

Figure 1 is a diagram illustrating four consecutive sections, AB, BC, CD and DE. Of these the three intermediate stations B, C and D are at times switched out. Herein the original type of electrical train staff instruments is mentioned as used for the short section working, and the later form of miniature electrical train staff arrangement for the long section. This detail, however, is not an essential part of the scheme; for both kinds of working there may be the same types of staff instrument with varying types of staffs, or, as previously mentioned, the combination of any of the other forms of electrical token systems.

A view of the switching-out control required at the intermediate stations is given in figure 3, and the terminal switching-out control at one of the two extreme stations of each long section — E in figure 1 — is given in figure 5. These two types of controls, as shown, are as when normal, *i. e.*, when short section working is in operation. To proceed to long section working a long section staff is required, and this normally is locked in the upper drawer of the terminal control, figure 5. Before this long section staff can be released, a staff must be obtained for each of the short sections. This is accomplished by B as regards section AB, by C for BC, by D for CD, and by E for DE. The staffs so obtained by B, C and D are placed in the upper drawer of the control, figure 3. The preliminary movement of this drawer enables the small lever on the left side of the control to be operated as in figure 4. The final movement of the drawer causes the same to be self-

locked, concurrently with the bridging up of the long section instruments line wire at each of the intermediate stations.



In *short* section working, the long section instruments are out of phase, owing to long section staff being secured in terminal switching-out control at E.

In *long* section working, the short section instruments are out of phase, owing to short section staffs being secured, one in each of the switching-out intermediate controls.

Long section line wire broken at B, C, D, E — and is pieced up when AB, BC, CD, DE — staff is locked in switching-out control, — AB, BC, CD, DE — staff released from drawer by BC, CD, DE, long section — staff being placed in its drawer.

The drawers cannot be operated until they contain their respective staffs. For short section working a long section staff is locked in the AE staff drawer and released hy DE staff being placed in its drawer, combined with current from long section instrument at A. This current, however, cannot be obtained until the long section line is pieced up at each intermediate passing place.

Fig. 1.

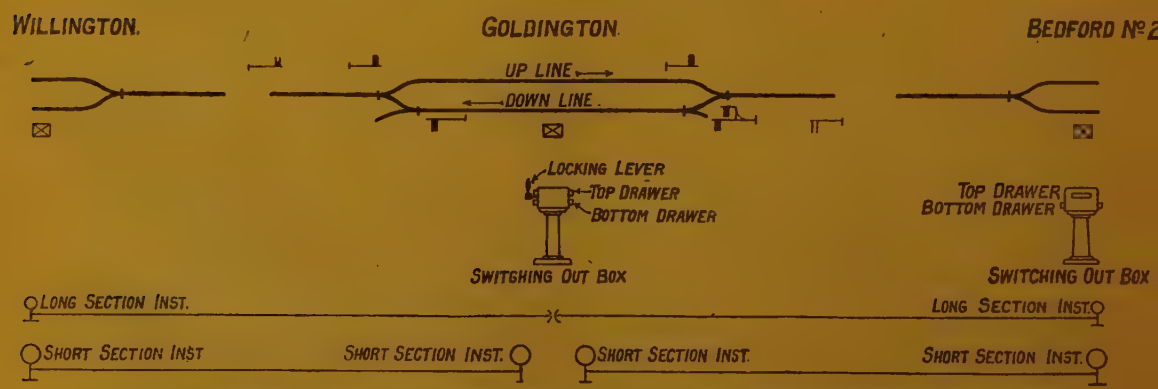


Fig. 2. — Switching-out installation between Bedford and Willington, London Midland & Scottish Railway.

This, as will be ascertained, is somewhat different to switching-out on double lines of railway mentioned in the opening remarks of this article. The intermediate staff instruments are not cut out but merely made non-operative for staff purposes. At the same time, the switching-out of the intermediates

connects the long section line wire at each place so dealt with.

The movement of the small lever referred to modifies the interlocking, and permits the road to be set for through running and for such running signals that conflict when short section working is in operation, to be free of such confliction for long section working.

The scheme in operation.

The short section staff, withdrawn at E for section DE, is placed in the lower drawer of the control, figure 5. A staff for each short section having been withdrawn and locked in its control, prevents any issue of short section staffs, but otherwise the short section instruments are not disturbed. When short section working is in operation the long section instrument wire is broken at each of the intermediate stations and is joined up by the back-locking of the intermediate short section staffs, one in each of the intermediate controls. The joining up of the long section wire does not make the long section instruments operative, for the reason that a long section staff is still locked in the upper drawer of the terminal control at E, figure 5. To extract the long section staff from this drawer a current is required from the long section instrument at A, along the long section line wire. Obviously, this cannot be obtained unless each of the intermediate stations have placed its staff in the control, as in figure 4, and as previously described. Thus receipt of current at E in the manner described is a guarantee that all the short sections are inoperative.

The long section staff can now be withdrawn from the upper drawer of the terminal switching-out control at E, and that instrument, instead of being as seen in figure 5, becomes as shown in figure 6. The staff from the upper drawer will now be placed in the long section instrument at E, and when the usual formalities have been carried out, long section working may be instituted.

The intermediate stations may be switched out in any order, the section DE, figure 1, may even be the first to be closed; but all must be closed before the long section staff can be released. The staff for the section on that side of the stations remote from the terminal must always be obtained at the intermediates for this purpose, *i. e.*, at C it will be for the BC section, as being the further from the terminal E.

Switching-in, however, must be done in sequence, as terminal E has to commence this function. This is accomplished by placing and self-locking a long section staff in the open upper drawer of the terminal control, figure 5. This operation cannot be accomplished until the long section is clear of traffic, and the operation just described prevents the further issue of long section staffs. This will then release the DE short section staff from the lower drawer, and, additionally, back-lock the long section staff in the terminal control.

The re-insertion of the short section staff in its own staff instrument at E will place the DE instruments in the operating condition, and that section is re-opened.

Section CD remains closed, and to obtain this section staff from the control, figure 4, a staff for the DE section must be obtained by permission from E. This is placed in the lower drawer of this control at D, which, when done, will free the upper drawer wherein is locked the CD staff. The upper drawer can then be partially operated, which breaks the long section line wire and permits suitable movements of the small lever on the side of the control box to be made so that the interlocking is adjusted to cancel through working and restore sectional operation. This drawer may then be fully operated to obtain possession of the CD staff. That accomplished, the lower drawer again may be

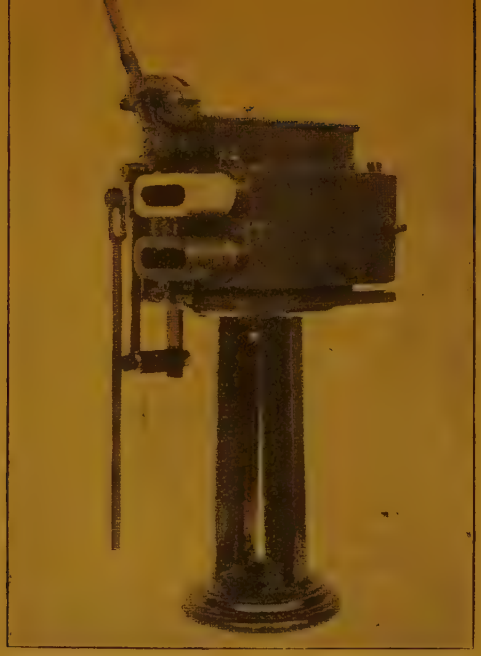


Fig. 3. — Switching-out control at intermediate station when normal, *i. e.*, short section working in force.

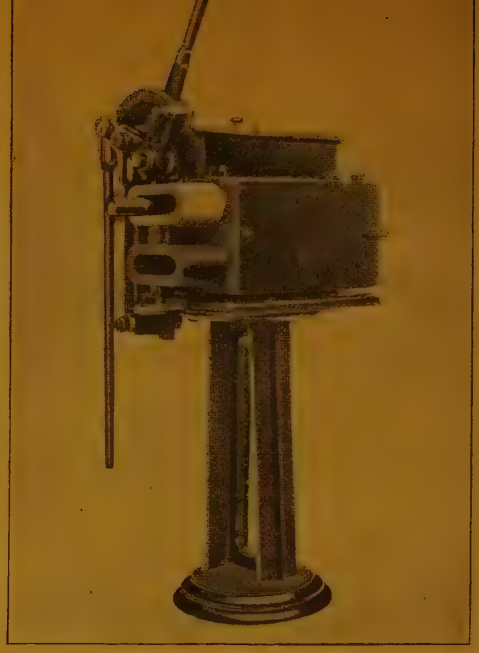


Fig. 4. — Switching-out control at intermediate station ready for switching-out.

A short section staff has been placed in the upper drawer and the control lever pulled over, modifying the interlocking so that one of the passing loops can be used in either direction.

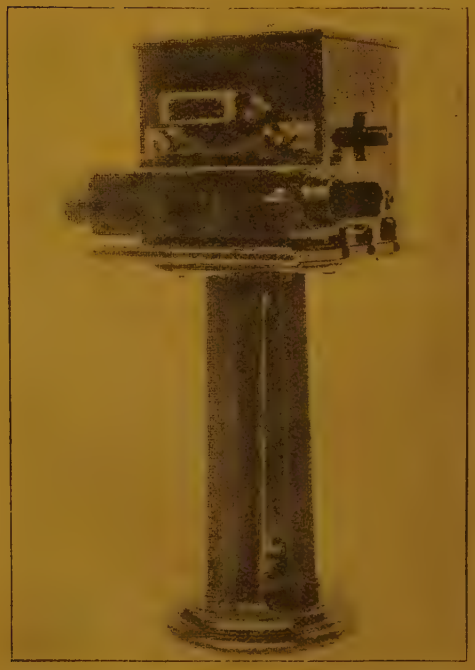


Fig. 5. — Terminal switching control when normal, *i. e.*, short section working in force.

Long section staff is locked in upper drawer.

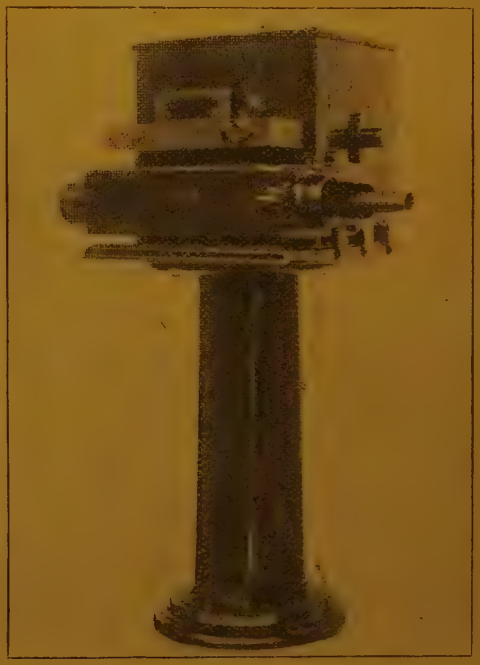


Fig. 6. — Terminal switching-out control when long section working is in force.

The short section staff is seen locked in the lower drawer and the upper drawer is open, and the long section staff withdrawn and in the long distance instrument.

opened and the DE staff placed back in its staff instrument, as also the CD staff. C then goes through the same routine as D, and then B, after going through the same movements, will complete the work.

It will have been understood that the small lever is that used for releasing the conflicting locking at crossing places, and for actuating any supplementary interlocking necessary. This lever is, of course, normally locked in either position, according to the conditions obtaining, and, in turn, is itself suitably interlocked according to the position of the intermediate staffs.

The principle of making the sectional instruments inoperative by withdrawing a staff from each section and securing the respective controls in order to make operative the long section working, and *vice versa*, is undoubtedly an excellent one. The same security is provided, in either case, as is offered by the abstraction and issue of staffs for train movements.

The installation at Bedford.

The installation of the switching-out apparatus now described has been made on the London Midland & Scottish Railway between Bedford and Willington on the Bletchley-Sandy section of that railway, and has been inspected by an inspecting officer of the Ministry of Transport. We would observe that here only one box — Goldington, figure 2 — is at present switched out, the long section being between Willington and Bedford. When Goldington is switched out all traffic is worked over the up passing loop. The insertion of a Willington-Goldington staff in the upper drawer of the intermediate control at the latter station will allow the small lever to be operated as previously described. This will permit both the loop facing points to be set for the up loop and for the up home, up starting, and the down-line-to-up-loop special home signal to be « off » together. The distants are kept in the « on » position.

The special home signal referred to is provided in this instance possibly owing to the lay-out of the loop points, but its introduction in all cases appears to be unnecessary. The normal condition of the distant signals also is a matter which can be left to the discretion of the railway concerned.

Outlying sidings here exist which are controlled by the short section staffs. These controls have now been arranged that the sidings can also be freed by the long section staff. This is an important feature, as it meets the objection hitherto prevailing that access to a siding controlled by a token is impracticable when that particular token is not available owing to the section being switched out. The point releasing mechanism is now so modified that the points can be operated by either a staff for the section in which the siding is situate or by a long section staff. There is no necessity to supply a separate locking mechanism for the long section staff, as this mechanism permits either a long or short section staff to release the points. Whichever staff is used is, of course, secured in the lock until the points are placed normal.

A similar idea can be provided, if requisite, so that points controlled from a switched-out cabin may be used when the same is closed and thus enable vehicles to be attached or detached at such stations during the period the station is closed.

The desirable extension.

The Abermule accident of January, 1921, suggests a very useful application of this long section working. Some important fast trains now run over single lines, and it is necessary that these trains should not be delayed between their regular calling stations. That the line

is clear to the next calling station, that the points are correctly set and the signals lowered at the intermediate stations, and that there are no intermediate tokens to exchange, nor, consequently, any possibility of error, would be guaranteed by adopting long section working temporarily between two more important stations for such fast trains. An arrangement like this, moreover, gives the drivers greater confidence, and makes the road more suitable for high speeds than is possibly the case by allowing the short sectional working to be in operation for such traffic.

Generally, the scheme has many attractions, and we can speak from personal inspection of its safety. Economy also largely enters into the proposition, for signal cabins may be closed not only at night or on Sundays, but, if required, at any other period. Cabins may be more frequently closed unless the long section would be of an inconvenient length for following trains, or because trains from opposite directions were required to cross. The attachment or detachment of vehicles being capable of accomplishment without any other assistance than the train crew is another consideration. Finally, in an emergency, short section working can be quickly restored if and when so desired.

The scheme has been introduced at an opportune moment, as some double lines, due to the grouping, may not have such heavy traffics as formerly; these may be so reduced that they can be converted to single lines. Such would, as was pointed out in an Editorial Note in the *Railway Gazette* of 9 July 1920, effect many economies. It would not only reduce, by practically one-half, the amount of track to be maintained and renewed, but there need not be any signals or signalmen at those stations or sidings which are not used for passing purposes. The safety of single lines, too, is proverbial.

We are indebted to Mr. J. T. Roberts, Engineer, Signals and Telegraphs, London Midland & Scottish Railway, London & North Western Section, for an opportunity to inspect this installation and its method of working, and would state that the apparatus was supplied by the Railway Signal Co., Ltd., of 40, The Broadway, Westminster, London, S. W. 1, the whole being manufactured at the works at Fazakerley, Liverpool.

[621 .33 (.82)]

Inauguration of electric traction on the suburban lines of the Buenos Ayres Western Railway.

Figs. 1 to 6, pp. 304 to 307.

The Buenos Ayres Western Railway is the oldest railway operating in the Argentine Republic. From 1857 to 1890 it was worked by the Government; in 1890 it was sold and since then has been controlled by a British owned company. The railway has a mileage of 1 882 miles and extends from Buenos Ayres to the foot of the Andes. On the 30 April 1923, Dr. Marcelo T. de Alvear, President of the Argentine Republic, inaugurated the new electric service.

The majority of the population of the Republic is concentrated in the immediate neighbourhood of the Capital. During the year ending June 1922, the number of passengers carried was 11 000 000, of whom 9 000 000 were carried on the

lines dealt with in the present article.

A glance at the map (fig. 1) will show the lay-out of the four principal railways serving the neighbourhood of Buenos Ayres. The necessity of arranging for passengers to be carried into the heart of the city over the lines of the « Anglo-Argentine » underground railway was the factor which decided the question of employing electric traction.

In 1913, Messrs. Merz and McLellan, the English electrical consulting engineers, drew up a report on the question of electrification. The work was actually commenced the same year, but owing to the war, it was ten years before it was completed.

Although the main portion of the electrified system is devoted to passenger traffic, goods trains are drawn electrically through a tunnel under the city from the Once terminus to the port.

The works carried out comprise a central station of 25 000 kw.; 72 1/2 miles of high tension cables, and 70 miles of single line which has been electrified. Three-phase current is sent out of the central station at 20 000 volts and 25 cycles, and at this pressure it is transmitted to four traction sub-stations having rotary converters of a total capacity of 10 000 kw. at normal rating and 15 000 kw. for two hours. These rotary converters deliver current to the third rail at 800 volts D. C. For power and lighting of workshops, etc., 7 000 kw. are required, and this power is provided for at six static transformer stations, two being situated in the rotary converter sub-stations. Frequency changers are provided to deal with the supplies to the workshops, etc., converting the supply from 25 to 50 cycles.

The plant and rolling stock has been supplied by British firms.

Central station.

The central station does not differ in any respect from the usual standard practice.

In the boiler house are installed seven Babcock & Wilcox marine type boilers working at 210 lb. per square inch and evaporating 20 000 lb. of water per hour. The heating surface of each boiler is 4 170 square feet, the grate area being 98 square feet. The *Underfeed* type of mechanical stoker is used, and each boiler is provided with its own economiser and superheater.

In the engine room are three turbo-alternators each of 7 500 kw. continuous capacity at 1 500 revolutions per minute. They are Metropolitan-Vickers manufacture and of the Rateau type. Current is generated at 2 500 volts and transformed up to 20 000 volts.

Each set is completely independent, so that any breakdown would only affect one group.

On the switchboard all switching is carried out at 20 000 volts; duplicate bus bars make it very easy to cut out defective machines or cables.

Underground cables.

The high tension current is carried at 20 000 volts by three core concentric paper insulated cables, each core being 0.1 square inch in section and of split conductor type : in addition to lead sheathing, the cables have single wire armouring and are compounded over all.

In the same trench as the power cables is placed a group of telephone cables, which allow of telephonic communication being made between different points on the line.

Sub-stations.

The electrified line is fed with 800 volt continuous current from four sub-stations placed 5/8, 5 5/8, 14 and 23 miles from the terminus at Buenos Ayres.

The buildings of the sub-stations are identical in design. Each is divided into three separate compartments containing respectively the switchgear, the rotary converters, and the transformers.

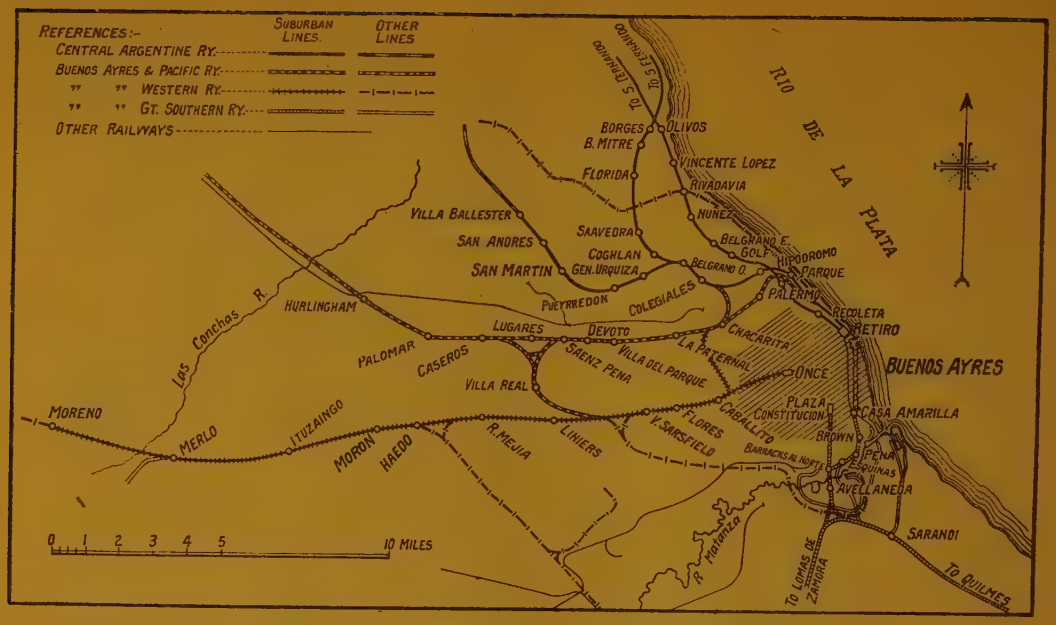


Fig. 1. — Map showing Buenos Ayres suburban lines.

Fig. 2. — Interior of Liniers static transformer substation.

Two of the sub-stations contain, in addition, auxiliary static transformers for dealing with the current for lighting and power. The Reyrolle ironclad type of switchgear has been adopted by the Company for all the static transformer sub-stations.

Third rail

The third rail is to the following specification :

Weight (lb. per yard)		86 lb.
Length		40 feet.
Analysis	Carbon	0.03 to 0.06 %
	Silican	Trace.
	Sulphur	0.04 to 0.07 %
	Phosphorus	0.04 to 0.07 %
	Manganese	0.3 to 0.5 %
Resistance		6.7 times that of copper of equal volume.

The conductor rail is divided into sections by switches mounted in signal cabins and so arranged that the signalmen can isolate quickly any section which is defective. As will be seen from figure 3, the same type of lever is used for operating these switches as is used for signalling.

The type of third rail used is shown in figure 4. The collector shoes which pick up the current make contact with the underside of the top member of the conductor rail. This type of third rail lends itself admirably to effective isolation and protection against accidental contact with it.

An overhead wire is substituted for the third rail on the lines serving the port.

Rolling stock

The rolling stock is arranged for multiple-unit working; it consists of the following vehicles :

25 first class motor coaches;
21 second class motor coaches;
25 first class trailer coaches;
20 second class trailer coaches;
1 composition motor coach, and
2 locomotives for goods traffic.

The coaches are of the type having a central corridor with cross seats. In the first class there are two seats on each side of the centre gangway, and in the second class, three seats on one side and two on the other. Each coach is divided by a partition into smoking and non-smoking compartments. The motor coaches having a driving compartment at each end, whilst a compartment is provided at one end of the trailer vehicles.

All the vehicles are provided with the vacuum brake. Each bogie of the motor vehicles has a 24 inch brake cylinder, whilst 18 inch cylinders are provided on each bogie of the trailer vehicles. The driver's brake valve works a small controller which regulates the speed of the motors driving the vacuum pumps. These run at half speed in the braking and running positions, and at full speed in the running position. The vacuum pumps have a capacity of 125 cubic feet of free air per unit at full speed. One pump will create a vacuum of 20 inches in 12 seconds, after it has been completely destroyed, in the brake system of a motor and two trailer vehicles.

The motor vehicles are carried on two bogies each fitted with two 220 H. P. motors. The average acceleration on the level of a train of two motor and two trailer vehicles is 1.25 miles per hour per second up to a speed of 22 miles per hour with an average acceleration current of 290 amperes per hour.

With a train consisting of two motor and four trailer coaches the acceleration falls to 0.8 miles per hour per second with a current of 270 amperes per motor.

The motors of each bogie are permanently connected in parallel, the two pairs of motors of a coach are connected in series or in parallel as required.

The multiple-unit control system is

Fig. 3. — Track sectionning levers.

Fig. 4. — View of under-running contact third rail.

Fig. 5. — Six-coach electric train.

fitted with an arrangement to give automatic acceleration at starting. A special relay is arranged for use, where necessary, when running up the incline of 1 in 26 which occurs near the Buenos Ayres terminus.

Fig. 6. — Interior of first-class electric coach.

The following are the details of the electrical equipment :

H. P. of motor	220 H. P. on one-hour rating (75° C. rise).
Voltage across motor	800
Diameter of armature	18 inches.
Core length	18 inches.
Diameter of commutator	15 inches.
Weight of motor, including gears and gear cases	7 120 lb.
Number of teeth in gear wheel	72
— — in pinion	21
Wheel diameter	3 ft. 6 in.

The following figures give particulars of the coaches :

	Motor coaches.	*Trailers.*
Length over buffers	62 feet.	63 ft. 4 1/4 in.
Centre of bogies	39 ft. 3 in.	41 ft. 4 1/4 in.
Number of first-class seats	64	68
— of second-class seats	88	96
Wheelbase of bogie	8 ft. 6 in.	7 ft. 6 in.

Weight of rolling stock (empty) :	*1st class : Motors.*	*2nd class : Motors.*	*1st class : Trailers.*	*2nd class : Trailers.*
	Tons.	Tons.	Tons.	Tons.
Coach body, underframe and bogies	38	37.3	34.1	34.1
Electrical equipment	18	18	0.9	0.9
Total weight	56	55.3	35.0	35.0
Weight per passenger seat	0.875	0.63	0.515	0.51

The two goods locomotives are of the 0-4-4-0 type and are arranged so that they can pick up current either from the third rail or the trolley wire.

The motors are practically the same as those fitted to the motor coaches.

The tractive effort on first step of controller is 10 000 lb., the current per motor being 165 amperes. The total weight which is all available for adhesion is 62 1/2 tons.

E. U.

[621 .138 (.73]

Shop scheduling and production control (1)

(Marked economies after six months' operation by Chicago, Rock Island and Pacific Railway in its locomotive shops at Silvis, Ill.),

By Laurence C. BOWES,

PRODUCTION ENGINEER, CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

Figs. 1 to 3, pp. 310 and 313.

(*Railway Review.*)

A study of the progress of industrial organizations discloses that the complexity of our modern industry, the rapid growth of division of labor, mass production and the continually increasing size of the industrial unit, have developed a need for a special study along scientific lines, to arrive at a satisfactory answer to the industrial problem. It is only by scientific analysis and the recording of our findings, that we can deduce the principles and laws of true management, and evolve a suitable organization. The principles of such organization are the centralized control and the three basic functions of any shop, *i. e.;* 1° planning; 2° processing; 3° inspection, and the complete delegated authority of each organizational unit within itself, with the proper understanding of the two great divisions of function and routine.

It is not unusual to find in a railroad shop that all three of these functions are the responsibility of the foreman. Each department head attempting to plan his work, on the basis of what the other department heads will plan, inspects all of his own work, as received and as delivered, and orders and follows material, all this in addition to his duty as a supervisor of his department.

(1) Extracted from a paper read before the Western Railway Club, Chicago, 17 December 1923.

It is evident therefore that there is a considerable overlapping of not only the functions performed, but the routine of performance, or organization for following out these functions. It is also apparent that a great difficulty is experienced in attempting to correlate the activities of the various departments, which correlation is necessary to provide for the most efficient sequence of both major and detail operations providing for a continuous and uniform flow of production.

To provide for complete production control, it is therefore evident that a proper grouping of unit activities under several central organizations is necessary. In the sequence of their relative importance, these unit activities, as indicated by chart (figure 1) accompanying, are divided into six heads, as follows : 1. Production division. — 2. Processing division. — 3. Inspection division. — 4. Plant division. — 5. Personnel division. — 6. Cost accounting division. The following tabulation indicates the functions of each of these respective divisions :

Production division.

A) Technical. Operation and material analysis, time studies, wage payments, capacity, operating statistics, shop layout, equipment analysis, tool record, equipment record.

B) Schedule : Schedule, routing, dispatch, material requisitions, production cards, time checkers and dispatchers, material delivery, trucking.

C) Material : Analysis of future schedule, locomotive work report, inspection reports; record of order, reserve, disburse.

Processing division.

Tool department.
Forge shop.
Machine shop.
Boiler shop.
Electrical department.
Stripping and erecting department.

Inspection division.

A) Receiving: Locomotives, back shop, material.

B) Processing : Material and operations in process, locomotives in back shop.

C) Finish : Locomotives in back shop, material and operations.

Plant division.

A) Power plant : Boiler room, engine room, maintenance.

B) Maintenance.

C) Watch service.

Personnel service.

Employment records.
Emergency and first aid.
Welfare and « safety first ».

Cost accounting

1° General accounting : Shop ledger, expense ledger, reports, invoices and vouchers;

2° Cost accounting : Detail costs, comparative costs, expense analysis, labor and material distribution, expense distribution;

3° Payroll : Timekeeping, payroll summaries;

4° Statistics.

The processing division functions only as to the responsibilities of actually performing the work as reflected on schedules created by the production division, and it is held responsible to the inspection division for accuracy of production.

The cost accounting division is directly responsible to the auditor of disbursements and not to the shop administrative office.

The foregoing has shown the functions of the several centralized divisions which are separate and distinct with complete authority within themselves, each report-

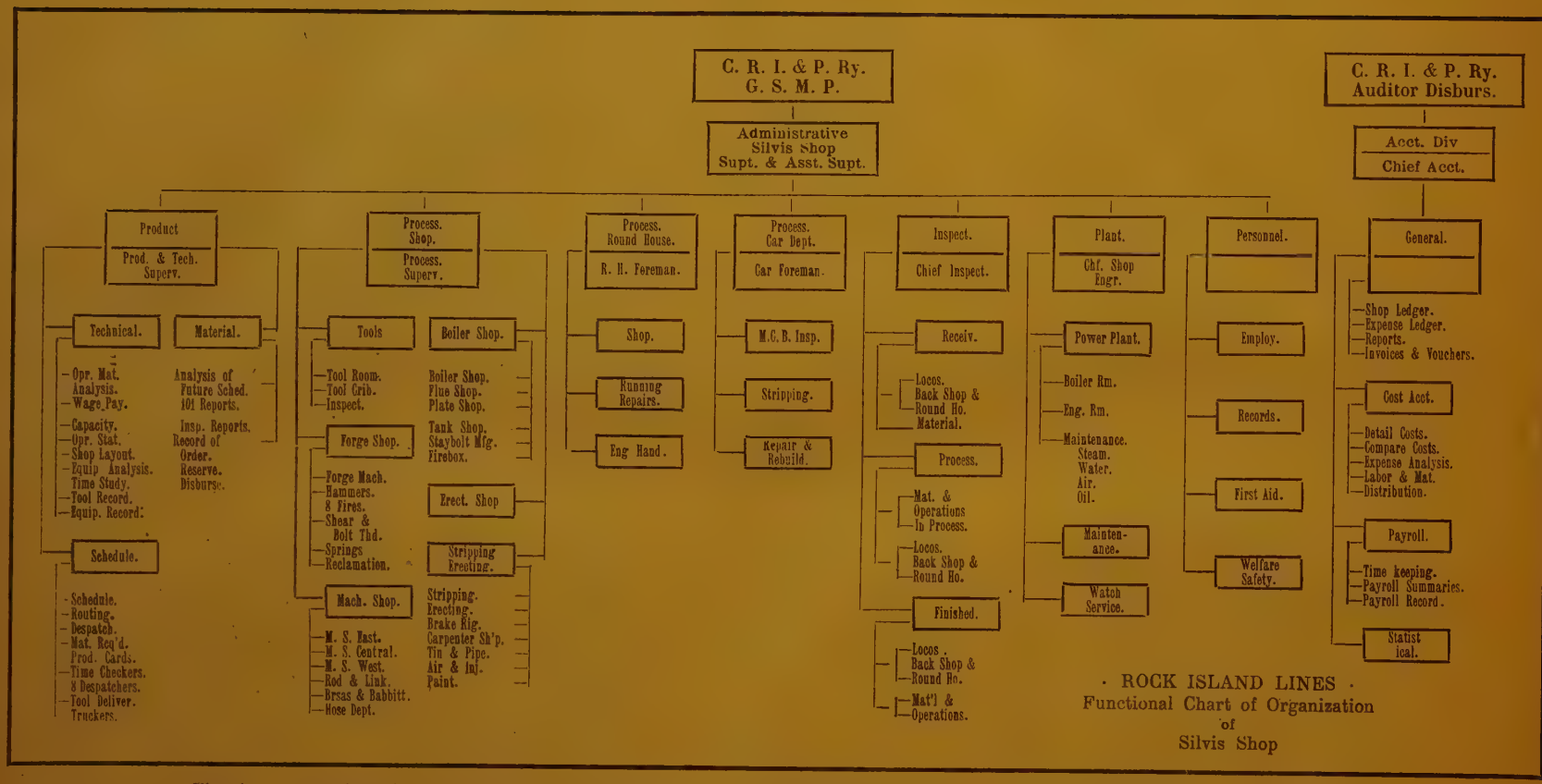


Fig. 1. — Grouping of unit activities in the locomotive shop as established at Silvis, Ill., Chicago Rock Island & Pacific Railway.

ing directly to the administrative office of the shop. We are now concerned with the routine of these functions.

At this point it may be stated that a complete understanding is necessary as to the difference between functions and routine. The functions are the duties or responsibilities of any particular division or activity. The routine is that organizational machinery and methods for performing the functions.

Routine of production control.

The proper basis for starting the consideration of the routine of production control is with the origination of the locomotive work report. This presupposes complete and definite analysis and the reporting of all necessary work to be performed on the locomotive assigned to the shop as lies within the capabilities of enginehouse and line organization, and such defects as may be revealed by effective enginehouse and line inspection.

The completeness of this locomotive work report is most vital in that it serves a double purpose, first that of providing prior data upon which to schedule the purchase of material; second, that of providing prior data for scheduling the locomotive in its proper course of overhauling in the back shop in its relation to the other activities, thereby providing a very definite means of maintaining the maximum in balance loading of all production facilities.

In addition to the necessity for completeness and accuracy of the locomotive work report, it was found necessary and possible to have these reports in the office of the superintendent of motive power at the same time that shopping lists are received from the line, which is at least 45 days in advance of the month in which the locomotives in question are scheduled for shopping. At the time the superintendent of motive power assigns these engines to the respective shops, the locomotive work report is released with the assignment. Too much stress cannot be laid upon the effective routine of the handling of this locomotive work report.

When this locomotive work report is received at the shop, it passes immediately into the material department of the production division, where it is carefully analyzed as to itself and its relation to the material schedule in general. When the data on this locomotive work report, by reason of its analysis, has found its proper place in the material schedule, authority is given the store department to provide for necessary material, as regards quantity and time requirements.

In conjunction with the analysis by the material department, the schedule department also analyzes the locomotive work report, and by considering the material schedule and the work schedule as reflected on the master schedule board, assigns the locomotive in question to its proper place on the master schedule. The important point to be brought out in this connection is that all the above routine is carried on prior to the actual arrival of the locomotive at the shop.

Before even attempting to schedule, and the consequent processing and inspection, it is imperative that there be complete, detailed and accurate technical data, originated and established by the technical department of the production division. This technical data incorporates the basic and most vital operating analysis which is the backbone of all shop activities.

Contrary to the general supposition heretofore that the secret of economical increase in production was the perfection of mechanical details of operation, it was found that the real controlling factor was the analysis and possible perfection of the activities reflected in : 1° Shop layout. 2° Shop capacities (vs. desired output); 3° Operation analysis : *a*) times; *b*) compensation; *c*) sequence of operations; *d*) routing of parts;

e) man-hour analysis; *f*) unit operations; *g*) tool analysis. 4° Equipment analysis and record. 5° Tool record. 6° Material delivery system. 7° Processing analysis. 8° Operating statistics. These are the responsibility of the technical department of the production division. Having this information available in record form, it is now possible to proceed with an effective production schedule.

When the locomotive is actually received at the shop, the receiving department of the inspection division makes its inspection of the locomotive (this form is so compiled that it is only necessary for the inspectors to check work to be done), immediately rendering a report jointly to material and schedule departments of the production division, which then makes the necessary analysis with respect to material and work schedules.

The schedule is made out on the « Schedule and Performance » sheet, and permits not only of recording schedule dates, but also of recording actual completion dates. One form is used with each locomotive scheduled, and never leaves the production office. It is arranged to show the major unit operations in the same sequence as shown on the

Master schedule board.

This master schedule board, the form of which is shown in figure 2, accompanying, is what is known as a three-dimension board, in that it schedules major unit operations, as against locomotives and as against calendar or schedule dates, any one of the three of which can be clearly visualized at a glance.

The mechanical construction of this board allows for complete flexibility. The unit operations are shown on printed tickets which can readily be regrouped as analysis may warrant. The calendar dates are also shown on printed tickets, which provides for a continuous rotation of all schedule operations. Further, locomotive numbers, signals and indications for scheduled work are also shown on removable tickets which permit the quick change of signals against scheduled operations, and the moving forward or backward of the ticket against scheduled work in the calendar section. This provides for a perpetual and easy-going schedule endeavor.

It will be noted that the several major unit operations are carried vertically down the center of the board. A major unit operation represents the completing of a number of single operations on correlated minor units, and the assembly of such units into a major part, which reflects a definite advancement in the progress of overhauling.

To the left of the operation column are ticketed locomotive numbers and signals for scheduled work, while to the right is the calendar section which carries the ticket showing the scheduled date for completing the various major unit operations on the locomotives scheduled.

A color scheme is used to further visualize the work. After a « Schedule and Performance » sheet has been made out for a locomotive arriving at the shop, a buff ticket carrying the locomotive number is placed at the top in the left hand section of the board. A blue ticket also carrying the locomotive number is placed in the calendar section of the board, under the scheduled date and opposite the scheduled major unit operation, a blank buff ticket being also placed opposite the same major unit operation to the left under the numbered ticket in the locomotive section of the board. This is continued for each major unit operation for all engines to be scheduled, in order of the sequence of « out dates » of scheduled locomotives. Thus, any day's work load can be instantly visualized by looking directly the date in the calendar section.

Each day this board is checked and tickets transferred to indicate completed and late dates. As each operation is

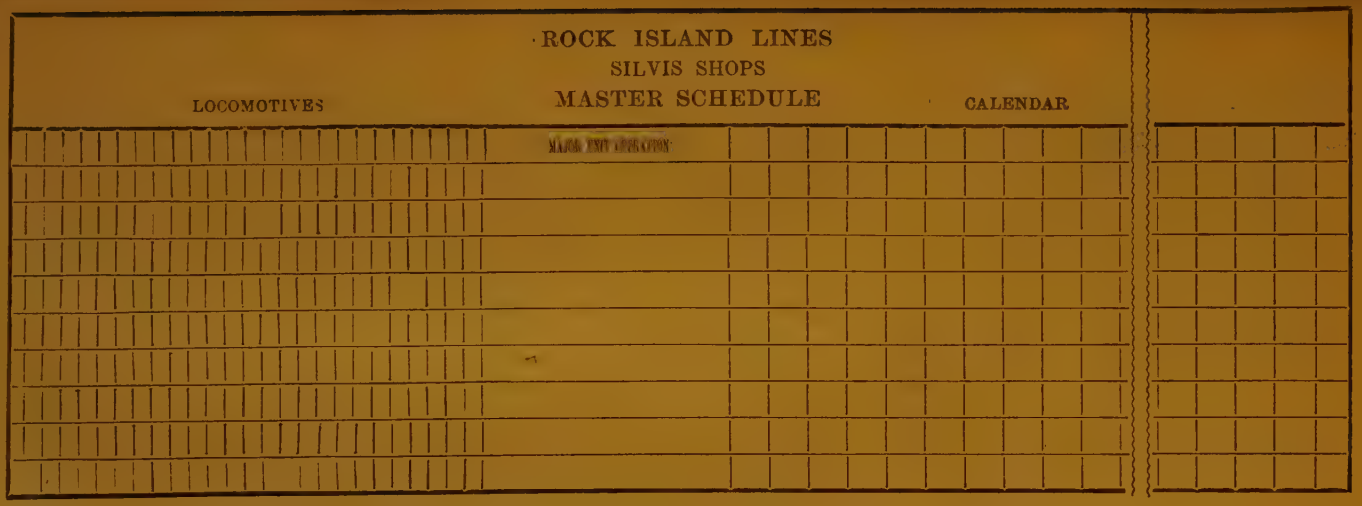


Fig. 2. — Master schedule board, Chicago, Rock Island & Pacific Railway, Silvis, Ill.

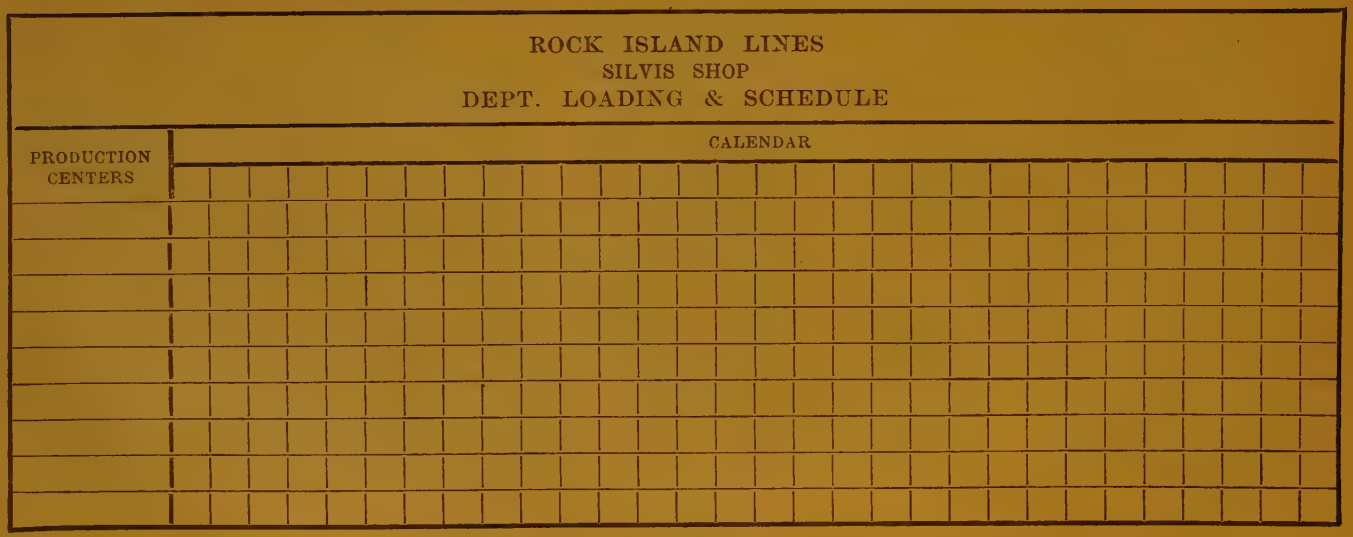


Fig. 3. — Departmental loading and scheduling board, Chicago, Rock Island & Pacific Railway, Silvis, Ill.

completed the numbered blue ticket in the calendar section reflecting that particular operation on the particular locomotive, is marked with actual completion date and transferred to the left hand section of the board, replacing the buff ticket under the proper locomotive number and opposite the proper operation.

Those operations which have not been completed on schedule, are indicated by replacing the buff blank ticket with a red blank ticket under the particular locomotive on the left hand section of the board, and opposite the late operation, the numbered blue ticket in the calendar section remaining until the operation is actually completed, after which it is marked with actual completion date and transferred to the left hand section of the board, replacing the blank red ticket.

Thus it is evident that the actual state of progress of any scheduled locomotive can instantly be visualized, as reflected by the length of the blue ticketed lines on the left hand section of the board. Further, the curve built up by the ends of the blue ticketed lines on the left hand section of the board reflects the general progress of the shop.

The danger points are obviously shown by the contrast of the red tickets, and are a signal for immediate action to learn the cause of delay and fix upon a remedy to prevent further delays.

The formation of the red tickets against certain operations is a valuable indication of the unbalanced conditions in the shop.

A delay sheet is kept of each locomotive, on which is recorded the cause of all delays. This sheet always remains in the production office.

When a locomotive has been « O. K.'d » to the transportation department, all numbered blue tickets pertaining to that locomotive will have been marked with actual completion dates and transferred to the left hand section of the board. They can then be entirely stripped from the board, and actual completion dates recorded in the « Schedule and Performance » sheet. This sheet is then filed away with its proper « Delay » sheet, for future reference for schedule analysis, and the tickets can be destroyed.

From the foregoing it is seen that a well maintained master schedule board will visualize the entire shop in a manner that cannot possibly be visualized by any one in passing around the shop.

Supporting the master schedule board are the departmental loading and scheduling boards.

Departmental loading and scheduling board.

The mechanical construction of these boards (see figure 3) is the same as the master schedule board and provides for the same flexibility. However, these boards are of the two-dimension type, scheduling work, as against production centers, as against scheduled dates.

A production center is any machine, group of machines, bench, pit or floor space, which can be considered as logically and practically assigned and confined to a specified activity.

With these boards, the locomotive is lost sight of as being a unit of production, but merely used for identification. The work loaded is the minor unit of production.

Production centers are shown down the left hand section of the board, on printed tickets to provide for any re-arrangement. The calendar section is shown to the right, calendar dates shown on printed tickets.

When the schedule divison receives the inspection report, a schedule on minor units is made out on a « Loading and Performance » sheet. This form is taken immediately to the departmental board and the boards loaded. The same removable tickets are used as with the master schedule board, the buff ticket representing all but final operations in minor

units. A blue ticket is used to indicate final operations on minor units, and in addition to the locomotive number, it also carries the schedule date. These tickets are loaded on the departmental board sufficiently far in advance of the schedule date to load the production center with a full day's work each working day.

In this manner also is loaded shop order or stores order for manufactured material.

As the loaded operations are completed, the buff tickets reflecting such operations are turned face to the board, while the blue tickets representing final operations on minor units are marked with actual completion date.

As a check is made of these departmental boards once or more each day, the buff tickets on completed work are destroyed, and the blue tickets representing completion of final operation on minor units are returned to the production office where the actual completion dates are entered on the « Loading and Performance » sheet, which information is used to check the master schedule board.

Thus it is seen that by the operation of the departmental boards, each production center is kept loaded at all times.

Supporting the departmental loading and scheduling boards are the dispatch booths and dispatch boards.

Dispatch booths and dispatch boards

These booths and the boards contained therein furnish the last connecting link between the workman and the schedule. The dispatch boards are merely a series of pockets numbered to correspond to the production center, in which are placed the production tickets.

At the time the departmental boards are loaded, the booth attendant writes the production ticket for the loaded operation. The workman calls at the booth, gives his number, name and ticket called for, enters the man's name and number, and the starting time, as the same time entering the stop time on the production ticket surrendered by the man. At the end of each day, the surrendered production tickets are checked against the clock stampings on the « in and out » card, which card runs for a payroll period.

The production ticket and the material requisition forms are made in triplicate and based on a unit system.

Unit system.

By allowing only a single unit to be placed on a production ticket, and material requisitions, it is then possible to sort these tickets in any manner desired for compilation of any and all information.

Similarly, the entire functions and routine of the production division are based on unit operations and analysis, which permits of readily obtaining unit costs.

The question naturally arises at this time, what has this accomplished ? After all of this study and analysis, and the operation of the system, what has been the result ?

Performance.

Perhaps the greatest accomplishment, and also that most difficult to measure, is the work of the technical division. By having an organization assigned to these functions, it has been possible to secure very close analysis of operations on which is being built a standard measurement of man-hours for the various classes of locomotive repairs. This analysis has further resulted in a more uniform output because of closer scheduling and the resulting more efficient routine. The entire shop now works to a maximum daily production rather than a monthly output, accomplished by reducing the lapsed times between operations.

In all, a correct visualization of all shop activities, by means of which it makes possible the opening up and immediate remedy of all delays to production.

To state the results concretely, during five months of operation, there has been a reduction in man-hours per locomotive in general heavy repairs of 33 % and an increase of 23 % in actual locomotive output. And this is accomplished without any routine forms passing around the shops.

In conclusion it should be said that the success of any attempt to establish such a system in any shop depends upon the complete understanding by all concerned of the principles of organization, and the faith in the endeavor. We are apt many times to permit ourselves to be blinded by the details, thus losing sight entirely of the principles involved. If the principle is right, the details will gravitate to a practical working level.

There is nothing mysterious about centralized control; it is only common sense systematically applied. But it is not automatic. It is a tool to be used, for the mere building of schedule boards will not remedy any faults. The entire system must be cut in and going, and that requires a tremendous amount of hard work.

And further, a production organization is not an office of clerical help, it is an organization of trained minds, highly specialized as regards the technical divisions, made up of men who face the facts squarely, no matter how formidable they are, men who cannot fool themselves, and thereby is obtained a true analysis.

Just a few words further concerning welfare work, on which the foregoing has a very important bearing, many times overlooked: with this we have completed the cycle of true management, which embraces not only the moral and social welfare of the employee, but also a well-organized and expeditiously-operated shop, which of course pre-supposes intensified scheduling which provides for steady employment.

To Mr. Mullinix, superintendent of Silvis shops, Chicago, Rock Island & Pacific Railway, and his organization are due the credit for the building up of, and to him and his organization will fall the responsibility for the perfection of the system of locomotive scheduling and production control described above.

MISCELLANEOUS INFORMATION

[656 .211.7 (.42 + .493]

1. — NORTH SEA TRAIN FERRY.

Opening of Harwich-Zeebrugge Service.

Figs. 1 to 4, pp. 318 to 320.

(*Modern Transport.*)

We understand that the new Harwich-Zeebrugge train-ferry service — a proposal which was described and illustrated in the 13 January 1923, issue of *Modern Transport* — will be opened for traffic some time in March 1924. It was originally anticipated that a much earlier opening date would be possible, but the work has been seriously retarded by reason of the disaster which befell two barges conveying the ferry bridge and lifting machinery from Southampton in September last. In our issue of 1 September we described the arrangements made for the transport of this exceptional consignment but subsequently had to report the fact that both barges had been sunk within a few miles of their destination. It was later found possible to salve the barge conveying the bridge itself, but the other, with the machinery on board, unfortunately proved a total loss. This loss had to be made good by dismantling similar lifting machinery from the war-time train-ferry berth at Richborough; this equipment, it is stated, is now on its way to Harwich. Had it not been for the railway strike and the consequent delay to the consignment, there is little doubt that traffic would have actually commenced on the new route on 1 March.

The promoters.

It will be remembered that, encouraged by the success of a temporary train-ferry service between Immingham and Calais, utilised for the conveyance of sleeping cars built by the Leeds Forge Co., Limited, for service on the French Railways (as to which an illustrated notice appeared in the 5 August 1922, issue of *Modern Transport*), a company, known as the Great Eastern Train Ferries, Limited, was promoted with the object of providing a new ferry service between this country and the Continent viâ Harwich and Zeebrugge. This company numbers amongst its directorate Lord Daryngton, of Pease and Parners, Limited, Lord Ailwyn, K. C. V. O., K. B. E., a director of the London & North Eastern Railway, which he will represent on the board of the new company, and Sir George Stapleton Barnes. Acting in association with the new undertaking and representing its interests on the Continent, is the « Société Belgo-Anglaise des Ferry Boats ». The scheme has the active support of the London & North Eastern Railway and of the Belgian Government — the owners of the railways in that country. The necessary rail connections to the ferry berth at Harwich have already been provided by the London & North Eastern Railway Company, who will operate and maintain the berth at this place, the berth itself being provided by the Train Ferry Company, for whom Sir W. G. Armstrong-Whitworth & Co., Limited, have acted as contractors. At Zeebrugge the train-ferry berth has been provided by the Belgian company at the site shown in one of the illustrations, while the Belgian Government, who are enthusiastic supporters of the scheme, have furnished the rail connection and also the rolling stock.

The new ferry berths.

The cost of the new berths at Harwich and Zeebrugge, shewn in the accompanying drawings, has approximated £60 000 and a million

francs respectively. At Harwich the berth is situated very close to the New Pier. A. J. Barry and Partners, of Queen Anne's Gate, Westminster, are consulting engineers for this undertaking. To meet variations in the rise and fall of the tide, an electrically-operated lifting bridge is being provided which will give a maximum slope of 1 in 20 as shewn in the diagrammatic section and in the small half-tone illustration. At Zeebrugge, however, such an arrangement will not be necessary as the berth will be built inside the first

Fig. 1. — One of the train ferry steamships, to be used on the Harwich-Zeebrugge service, berthed at Immingham Dock.

lock on the Zeebrugge-Bruges waterway. It should be mentioned that, as an additional facility on this side, the train ferry company has acquired the train-ferry berth at Immingham, above referred to. This berth will be used for the shipment of rolling stock and other exceptional consignments for which, on account of expense, the shortest possible rail haulage will be desirable.

Steamships.

The service will be operated by three of the steamships which were employed on the Continental ferry services from Richborough during the war. These vessels were built by Sir W. G. Armstrong-Whitworth and Co., Limited, and were fully described and illustrated in the 6 and 13 December 1919, issues of *Modern Transport*. It is proposed to utilise two of the vessels on the service and to keep one in reserve. One steamship will sail daily in each direction, leaving each side between 8 and 9 o'clock in the morning and arriving at its destination at about 5 p. m. The voyage of 84 miles will be covered at roughly 10 knots an hour, the actual sea passage occupying about eight hours, or from nine to ten hours from berth to berth. Although very little time will be occupied in berthing at Harwich, it is anticipated that, owing to the necessity of passing through the lock at Zeebrugge, approximately one hour will be taken by the vessel in gaining access to its beth there. The

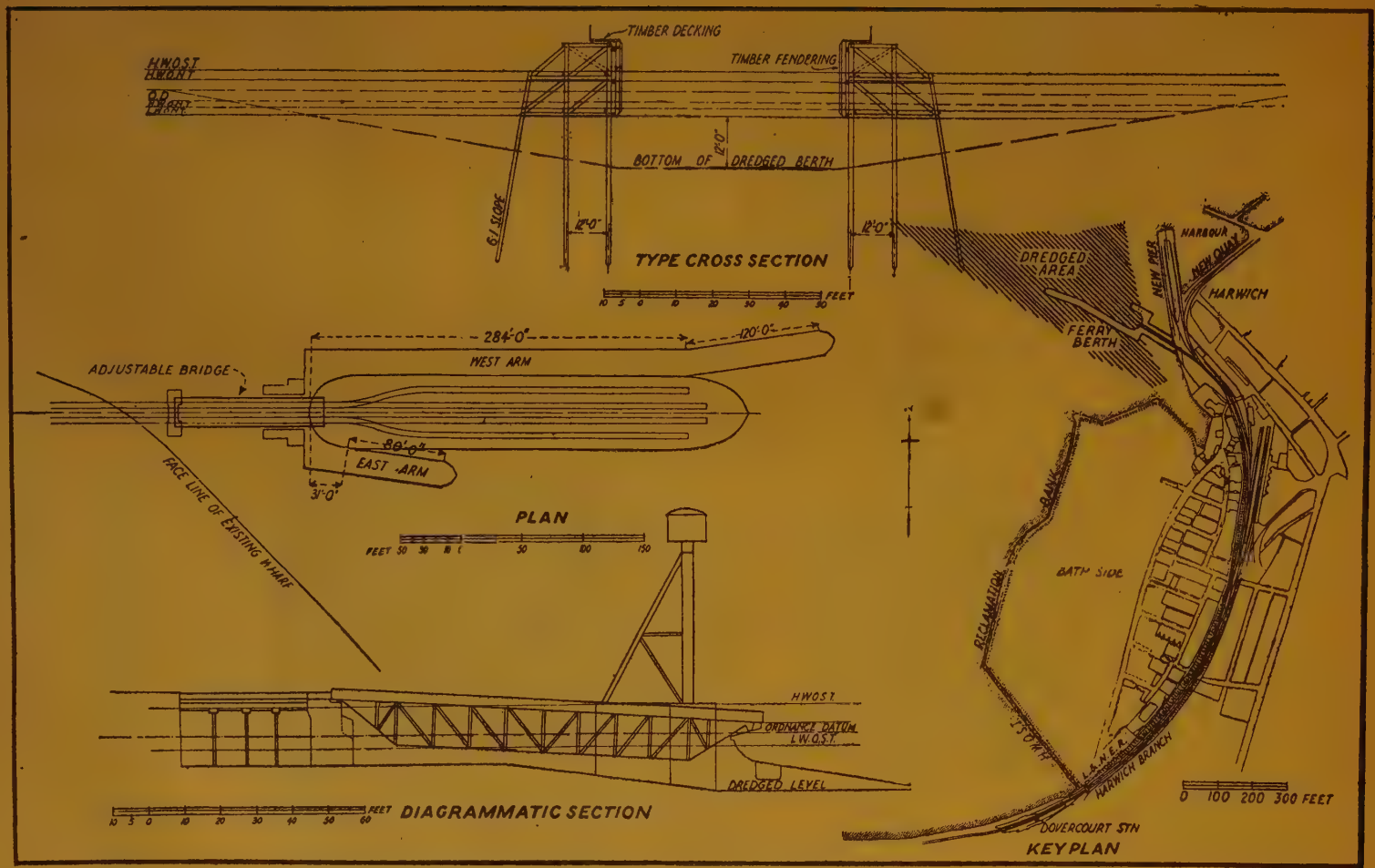


Fig. 2. — The new train ferry berth at Harwich : plans, section and elevation.

London & North Eastern Railway Company have undertaken to manage the service on behalf of the Great Eastern Train Ferries, Limited, and the latter company will, therefore, have the advantage of the organisation and agencies of the former undertaking on the Continent. The operations at Harwich will be under the control and supervision of the rail-

Fig. 3. — Plan showing position of train ferry berth at Zeebrugge.

way company's marine superintendent at that place.

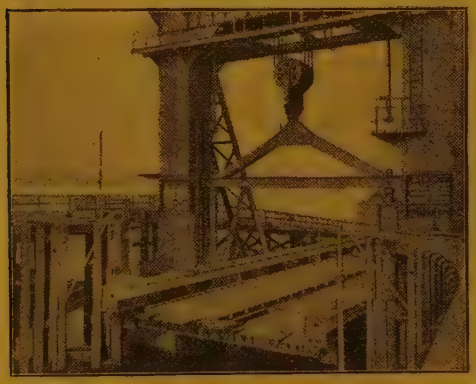


Fig. 4. — Communication bridge of train ferry berth, as used at Richborough.

Rolling stock.

The ferry company are particularly fortunate in the fact that they have been enabled to conclude arrangements for the use of rolling stock on most advantageous terms. It happens that the Belgian Government have available over 15 000 « common user » wagons which were built in Great Britain during the war to English specifications for use on the Western Front. These the Belgian Government have handed over to the ferry company for the purposes of new services.

Control of wagons.

The actual arrangements for the hire of the wagons have been entered into with the Belgian Government by the « Société Belgo-Anglaise des Ferry Boats », with whom, in turn, the English company have an agreement for the user. At the outset it is estimated that 5 000 wagons will be sufficient for the service, the remaining 10 000 being held in reserve. There will be a central wagon distribution office in Brussels, controlled by the Belgian company, and a similar control office will be set up in Milan operated by an affiliated Ita-

lian company, known as « The Ferry-Boats Company for England » and formed for the purpose of supervising vehicle movements and general administration in Italy. The intention is that Brussels and Milan shall each cover a zone embracing various important centres of production which will requisition their wagon supplies from the two Continental control offices. This arrangement lends itself to extension as and when necessary, and no difficulty is anticipated in keeping a close check upon the working of the wagons and avoiding undue standing time. Traffic from the commencement will be mainly in the nature of perishable, but, as the service gets more firmly established and its benefits become more widely known, it is expected to attract traffic of a much heavier character and volume. The principal advantage will be manifest in the avoidance of handling at either port. The cost of loading and unloading the ferry steamer, wagons being run on and off without any delay whatsoever, is estimated at 4 sh. per ton, as compared with an approximate expenditure of from 15 sh. to the 25 sh. per ton incurred when each individual consignment has to be transferred from train to ship and *vice-versa*.

[621 .336 (.42)]

2. — A new system of a protected under-contact conductor rail.

Fig. 5, p. 321.

The *Railway Gazette* for the 19 October 1923 publishes an article describing a new system of contact with the third rail, which, by means of several novel features, differs from that now in use.

Though a tension of 750 volts is rarely exceeded by methods now in vogue, those interested in this new arrangement state that they are highly satisfied with the result of the trials which have taken place at Manchester, during a period of nine months, working with a tension of 1 200 volts.

Fig. 5. — Collector shoe in under-contact position.

The figure 5 shown gives an idea how this recently proposed system is fitted up.

E. U.

[385. (09.2]

3. — Retirement of Sir Arthur Watson, first general manager, London Midland & Scottish Railway, member of the Permanent Commission of the International Railway Congress, and of Mr. Roger T. Smith, electrical engineer, Great Western Railway, member of the organising committee of the London Congress (1925).

The following is the text of articles by means of which the *Railway Gazette* informed of the resignation of our eminent and sympathetic colleagues, Sir Arthur Watson and Mr. Roger T. Smith :

It has taken little more than a year of « railway grouping » to bring about the first casualty amongst the general managers. Lord Lawrence, at the first annual meeting of the London Midland & Scottish Railway, held in the Great Hall at Euston last Friday, announced that Sir Arthur Watson had asked to be relieved of his duties owing to ill-health. Continuing, he said : « His connection, first with the Lancashire & Yorkshire, then with the London & North Western, and, finally, as the general manager of this great amalgamated company, has been distinguished, and we owe him a great debt of gratitude for his untiring industry and success in the amalgamation and absorption of our various companies and for his efforts in consolidating them. Unfortunately, his health has broken down in this colossal task, and, in thanking him for all he has done for us, we wish him every happiness in his retirement, and a speedy return to a normal condition of health. »

Sir Arthur Watson has had a wonderfully full railway career — one now, alas! cut short in its early maturity. First as engineer of the old Lancashire & Yorkshire Railway, next as Superintendent of the Line, then as deputy for Sir John Aspinall (when the latter was interned in Germany), and finally as general manager of the Lancashire & Yorkshire, the London & North Western, and the London Midland & Scottish Railways in rapid succession. Though he was undoubtedly feeling the strain of his great efforts in recent months, Sir Arthur still retained his equable temperament and charm of manner, as we ourselves can testify from recent meetings with him. In his retirement the London Midland & Scottish Company have lost a man of outstanding ability. The staff, moreover, have lost a friend — in the truest meaning of that word.

Small wonder that the task of organising and administering such a colossal undertaking, when added to the burden of steering a safe course through the shoals of grouping difficulties, has proved too much for human frailty. Let it be recalled that this great system, which comprises over 7 000 route miles of line, extends from London to Wick, from Southend to Donegal, and from Swansea to Goole. The total capital is almost £400 000 000, the gross receipts are over £87 000 000 (or equal to the pre-war revenue of the Indian Empire), and the expenditure over £70 000 000, while the personnel comprises 269 000 employees. In brief, the London Midland & Scottish Railway financial totals represent more than 40 % of the aggregate of the four large companies. The control of such an undertaking is a gigantic task, and unfortunately it has proved too great for the health of its first general manager. We sincerely hope, and are sure our readers will join us in the expression, that now he is freed from the burden of office, Sir Arthur Watson will soon be fully restored to health, and be able to devote the benefit of his wide knowledge and experience — possibly in a less exacting manner — to the cause of British railways. A portrait of Sir Arthur Watson was published in these pages as recently as 4 January 1924, on the occasion of his knighthood.

* * *

Mr. Roger T. Smith, B. Sc. (London),

M. Inst. C. E., M. I. M. E., M. I. E. E., who has retired from the position of electrical engineer to the Great Western Railway, had held that appointment since 1905. Educated at University College, London, 1880 to 1885, from 1886 to 1890 Mr. Smith served with Hathorn, Davey & Company, of Leeds, first as pupil and then as erection charge hand. From 1890 to 1893 he was engaged on the erection and maintenance of machinery in India with Easton, Anderson & Goolden, Limited. Returning to England, he devoted some time to an electrical engineering and laboratory course at University College, London, where he was prizeman in electrical engineering. He was then appointed Resident Engineer, under Sir Alexander Kennedy, to the Westminster Electric Supply Corporation, and from 1895 to 1898 was Technical Manager for the « Imperial Continental Gas Association » of « La Compagnie Hydro-Electrique Anversoise », supplying Antwerp with hydraulic and electric power. In 1898 he joined Sir Alexander Kennedy's staff as an assistant concerned with surveys and preliminary designs for electric supply schemes, railways and tramways. He went to Buenos Ayres in connection with the City electric tramway scheme and the design of the generating station. He was then placed in charge of electric railway, power and lighting developments for the Great Western Railway, and in 1905 joined the Great Western Railway Company as their electrical engineer. In that position he was in charge of the supply of electricity for traction, power and lighting in the London district, including generating station and other works, as well as the electrical plant generally. He was also electrical engineer for the Ealing & Shepher's Bush Railway. Mr. Smith was President of the Institution of Electrical Engineers for 1919-1920. He was awarded the George Stephenson Gold Medal for a paper on « Electric Train Lighting », read before the Institution of Civil Engineers in 1911. He represented the Railway Executive Committee as a witness before the Board of Trade Electric Power Supply Committee in 1917, and has been concerned since with various bodies as a representative of the railway companies.

We join with the *Railway Gazette* in wishing our esteemed colleague Sir Arthur Watson a rapid return of health.

The Executive Committee.

NEW BOOKS AND PUBLICATIONS

[385 .3 (.73) & 385. (.04]

CUNNINGHAM (W. J.), A. M. professor of Harvard University. — **American Railroads : Government control and reconstruction policies.** — One volume in-8vo (8 × 5 1/2 inches) of 409 pages. — 1922, Publishers : A. W. Shaw Company, Chicago, New York and London — Price : $3 net.

The railways have played, during the war, a very important part even in countries which, without being directly affected by the hostilities, took nevertheless an active part in the conflict. In order to assure the greatest amount of co-operation, which element is essential to success, the Governments of the belligerent nations were obliged to take exceptional methods of control, aiming always at efficient management, methods thought out in times of peace in one country, but improvised more or less hurriedly in others.

This was also the case in America where, though the first steps were taken at the initiative of the companies, Government intervention did not take place until sometime after the declaration of war.

Mr. Cunningham's book gives us the history of the working of the American railways by the State during the 26 months it lasted (from the 1 January 1918 until the 1 March 1920). The author, who held responsible positions on the staff of the Director General of Railways, saw at close quarters the events which he relates, and he takes from a reliable source the information which he publishes.

In order to understand fully and to enable one to appreciate the conditions existing in 1917, he shows first of all the position of the railway companies before the war. This position was far from brilliant. The increasingly powerful interference by public bodies had shown itself chiefly in the control of rates, coincident with constantly increasing overhead charges, and had little by little diminished the success of the carriers and gradually reduced the possibility of their carrying out the necessary extensions of their lines. One could almost foresee a financial catastrophy when the war broke out and the enormous traffic, due to the orders of the Allies, brought in additional receipts. The result was that the year 1916 beat all previous records, but this increase in traffic also taxed those resources which were unprepared for a lengthy ordeal, and in April 1917 one finds that the lines had reached their full capacity.

Anxious to give the Government every possible help in the war, the directors of the companies realised the necessity for co-ordination, and they instituted the Railroads War Board, represented by an Executive Committee composed of five members.

In contrast to what happened in England, however, the agreement took place between the companies without Government intervention. In acting thus, the American railroadmen hoped through a feeling of patriotism to show to the public what private administration could do and thus provide a serious argument against those who looked for the only solution of the railway problem in nationalisation. Although the results appear to have been satisfactory at first sight, one soon discovers that with this sole organisation the railways remained

unequal to their task. The author points out the causes : lack of accommodation and of rolling stock and the impossibility of the companies being able to remedy this owing to want of financial resources, acceptance of traffic for transport by rail regardless of the possibilities of shipment and the existence amongst the officials of the spirit of rivalry which had existed between them for so long. At the end of 1917 the position had become acute, the stations serving the Atlantic ports were heavily congested. In addition, the measures taken at the initiative of the companies were in opposition to the existing laws which had previously been passed to combat pooling and the trusts. These were the conditions when the President, using the power which he held under a law passed in August 1916 to cope with anticipated difficulties with Mexico, took possession of the railways and appointed M. William G. McAdoo, formerly Secretary to the Treasury, Director General. The motives which brought about this decision were of a financial nature throughout, the Government alone being legally able to effect complete unification of the railways and provide the necessary management. The rise in the cost of living and the shortage of labour gave rise to demands on the part of the staff, which were supported by threats of strikes, and these had to be dealt with without delay.

The voluntary amalgamation was thus followed by a complete amalgamation with a Central State Administration. The author gives the history and a detailed criticism of the working of this State Administration in the course of seventeen chapters (chapters IV to XX). Two periods are dealt with under this regime : the first extending from the beginning of 1918 until the end of the war; the second extending until the 1 March 1920, the date on which the railways were restored to private management.

The relations between the federal authority and the directors of the railway companies were not, as one can understand, regulated in any definite manner at first. The Director General was at first, under the terms of the proclamation of the President, instructed to take possession of the lines of transport, the management, the operation and the rolling stock, also the existing personnel. There was then placed under his charge all the work for the companies. The law of the 21 March 1918 which followed, established between the Director General and the companies, relations similar to those between tenant and landlord. The financial questions were the subject of a contract between the Government and the companies by virtue of this same law. The author analyses the essential details. One finds the complete text of this law at the end of the volume.

In chapters VI to XI the author explains the methods adopted by the Director General and the difficulties which were surmounted : common use of lines, stations and rolling stock, direct means of transport, standardisation of types of rolling stock, modification of the commercial service and of returns and accounts, reduction of the passenger service, the rates policy and the salaries of the staff.

Chapter XII, showing the results for the year 1918, gives one item of special interest. If the working resulted in a considerable deficit, one finds on the other hand that the ton-mileage of traffic exceeds that of all previous years, and that the « Railroad Administration » made all war transport certain, which was assuredly its primary object.

The second period presented a very different character from the first. The war was over, the main reason which caused the State to take over the railways had vanished. The financial policy was discussed with the companies and also how long the existing control should be continued and when the railways should be handed over to the owning companies. It is a suitable time for

examining the consequences of the action of the Government, and the author deals with it from various points of view. He also discusses the possibility of continuing the measure taken to effect an amalgamation of the lines of transport. In chapter XXI he analyses the law of 1920 (Transportation Act) which again placed the railways under the control of the companies, and gives the circumstances under which it was passed. He again reviews the events of 1920, paying particular attention to the resumption of private operation of the lines, then he deals with the position in 1921, and ends with a review of the situation in July 1921.

This 26 months of State control under absolutely abnormal conditions must not be considered as representing what might be a permanent working system. In particular, the large deficit, referred to previously, was due to momentary causes, rises in salaries and in the price of other things. He does no attempt to evade the fact that a rise in rates, which had fallen again in the last analysis, was itself a deficit on the public exchequer. Nevertheless, it seems improbable that the American railways will be nationalised for some time to come.

The experiment, however, is over, and from the discussions to which it gave rise, was evolved the idea of a partial amalgamation of lines of which the beginning is set down in the law. The question of grouping, of the fusion of the railways into a certain number of systems, actually decided on in England, is publicly discussed in America. The Interstate Commerce Commission have been instructed to prepare a plan for grouping, and whilst it has not the power to impose it on the companies, they are able to give to it all the publicity they desire through the interests concerned in making it known. Furthermore, all measures of this nature, in order to be of any value, are bound to receive their approval. The plan to which it is giving attention provides for the formation of nineteen great systems, uniting practically all the first class railways, but it is found that under the actual working of the law its adoption presents great difficulties.

E. M.

[385. (02 & 385. (04]

TORRE (Enrique de la), Editor of the *Gaceta de los Caminos de Hierro*. — **Anuario de ferrocarriles (Railway Annual)**. — One volume in-8vo (8 × 5 1/2 inches) of 24 + 352 pages. — 1923, Madrid, Enrique de la Torre, Publisher, 54, San Vicente Alta, and the offices of *Alrededor del mundo*, 65, Martin de los heros. — Price : cardboard covers, 5 pesetas; cloth covers, 6 pesetas.

We have before us the new edition of the annual which Mr. de la Torre has issued for the last thirty-one years. It deals principally with Spanish railways and gives the most useful information for officials and others who are directly or indirectly interested in matters relating to transport.

The work is divided into three parts. The first part, besides dealing with general information relating to patents taken out in 1922 in connection with the railway and tramway stock of all railways in the world, gives statistics concerning Spanish trade and production, accidents which occurred in Spain from 1916 to 1920, and particulars relating to speed and rolling stock, also details with regard to the postal and telegraph departments, and the main lines of this

country. It gives, in addition, a list of officials connected with the Ministry of Transport, as well as the staff under State control.

The second part gives the names of the various railway companies in Spain, their headquarters, capital invested, mileage, boards of directors, as well as a list of the officials of each railway down to station-masters. It also gives receipts and expenditure of each line in tabulated form, how the rolling stock is made up, and details relating to the mileage of secondary and strategical lines. Spanish tramways are also dealt with and particulars given relating to their headquarters, capital invested, mileage, boards of directors, names of the principal officials, as well as statistics concerning rolling stock and working results. It concludes with a list of names of the principal directors, managers, etc., of the large French railway companies, as well as those of the Portuguese lines.

The third part deals with the Spanish law relating to railways, and concludes with an alphabetical list of all the names mentioned in this annual.

A large and very clear map showing all Spanish railways is included in this work.

X.

[62. (01 & 385. (04]

NACHTERGAL (A.), engineer, technical school professor. — **Petit formulaire de résistance des matériaux (Short formulæ book for the strength of materials).** — One volume in 16mo (6 × 4 inches) of 86 pages, with 86 figures in the text. — 1922, Published by Alb. De Boeck, 265, rue Royale, Brussels. — Price : 3.50 francs.

This small volume is addressed chiefly to the students of technical schools. « This book of short formulæ » as the author states in his preface, « can simplify their work; all their attention can be kept on the subject of the lesson. The proof is of no importance to them, they see here the principal formulæ resulting from the theories worked out on the blackboard ».

This object will certainly be attained, for this small book gives, in a compact manner, all the formulæ very well explained. Any desired application is left to the professor in delivering his lecture. Blank pages are inserted to allow the student to make notes.

We are sure that all teachers in technical school will bring this formulæ book to the notice of their students.

J. V.

[621 .8 & 385. (04]

NACHTERGAL (A.), engineer, technical school professor. — **Appareils de levage (Lifting equipment).** — One volume in 8vo (9 1/2 × 6 1/4 inches) of 57 pages, with 82 figures in the text. — 1920, Published by Alb. De Boeck, 265, rue Royale, Brussels, and Ch. Béranger, publisher, 15, rue des Saints-Pères, Paris. — Price : 4 francs.

In this book Mr. Nachtergal has collected everything connected with the calculations for the lifting equipments which one meets with in modern running sheds.

As the author remarks in his preface :

« The lectures given on mechanics deal with the theory of this apparatus in a form sometimes difficult to understand. The elementary lectures do not give the rudiments and do not deal with any consideration of results. » It is this gap that he has attempted to fill, and we feel that he has been successful.

Whilst remaining very elementary in the explanation of the theories, it is very complete and deals with apparatus such as : pullies, tackle, winches, jacks, inclined planes, cranes, etc.

We think that the object it was sought to achieve has been attained, and that it will be useful both to mechanics and foremen.

J. V.

[62. (01, 721 .3 & 385. (04]

NACHTERGAL (A.), engineer, technical school professor. — **Calcul des colonnes métalliques (Calculations for metal columns)**, 2nd edition. — One volume in 8vo (8 1/4 × 4 3/4 inches) of 32 pages and 14 figures in the text. — 1919, Published by Alb. De Boeck, 265, rue Royale, Brussels, and Ch. Béranger, publisher, 15, rue des Saints-Pères, Paris. — Price : 2.50 francs.

In this volume, Mr. Nachtergal deals with the much discussed question of buckling. He gives at the commencement Euler's formula, which he states in a simple manner. It is evident that this theory can be criticised, but happily the author foresees this criticism, for he points out the faults in it.

M. Nachtergal states at once what his opinion of the Euler formula is : « It has been criticised in recent years. It is of interest to us in that we have always applied this formula to our metal construction work and we have never been mistaken. » We think that he has good reason for saying this. He insists equally strongly on the limits of the application of the Euler formula. These limits are, as a matter of fact, very often negligible for the designer, and are sometimes even omitted in low priced books of this description.

At the end we find the fourmulæ of Rankine and Tetmayer which are, in our opinion, the best to use when the Euler formula is at fault.

Of the numerous examples given, many will familiarise the reader with the problem of buckling.

J. V.

[62. (01 & 385. (04]

NACHTERGAL (A.), engineer, technical school professor. — **Aide-mémoire pratique de résistance des matériaux (Practical reference book on the strength of metals)**. — One volume in 8vo (9 1/2 × 6 1/2 inches) of 324 pages, with 470 figures in the text. — 1923, Published by A. De Boeck, 265, rue Royale, Brussels. — Price : 40 francs.

Mr. Nachtergal's reference book gives the formulæ in general use for calculating the strength of metal structures. He has written it for those engaged in technical pursuits, and for this reason begins with a short introduction calling attention to the chief points and notations that should be clearly understood in order to follow a course on the strength of materials. The author then touches on the principal tests which metals have to undergo. (Tensile, compression, etc.).

Each formula is accompanied with remarks in order to make it thoroughly lucid and easy of application. We think, however, that the author might have brought out more clearly the limits to which each one of the formulæ might be applied. Most of the failures which take place in fact due to the loose way formulæ are made use of. The limits to which the application of the formulæ relative to buckling for instance are very important. Mr. Nachtergal points them out, but the work would have gained in value if he had put them more in evidence.

Numerous tables of figures accompany the text and are a useful help in conjunction with the latter.

Finally, each chapter is followed by very interesting numerical applications, making it possible to deal with all cases met with in practice. Numerous working drawings accompany these examples, in order to show how the values obtained by calculation may be put to practical use.

We regret though that the author, when dealing with bending, does not mention the methods of graphical integration which are so simple and used so generally, allowing as they do the line of deflection to be found in all cases without making use of mathematical analysis.

The object for which the author has set himself out to achieve, namely, to be useful to technical men, has, we do not doubt, been amply attained.

J. V.

[624. (01 (.44) & 385. (04]

NACHTERGAL (A.), engineer, technical school professor. — **Notes, calculs et tableaux relatifs aux ponts de chemins de fer (Notes, calculations and tables relating to railway bridges).** — One volume in 8vo (11 × 7 1/2 inches) of 28 pages, with 30 figures in the text. — 1921, Published by Alb. De Boeck, 265, rue Royale, Brussels, and Ch. Béranger, publisher, 15, rues des Saints-Pères, Paris. — Price : 6 francs.

One finds in these notes the text of the French Ministerial Circular of the 8 January 1915 relating to calculations for testing of metal bridges.

The author himself has added explanatory notes with the object of showing how they may be applied to bridges of a single span. The numerous calculations and tables give the value which occur in practical calculations.

J. V.